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Technology Insertion (TI)/Industrial Process Improvement (IPI) Summary Report for WR-ALC . This document contains Focus Study and Quick Fix Recommendations for the 7 Resource Control Centers (RCC's). These RCC's are: MANPGA, MANPGB, MANPGC, MANPSA, MANPSB, MANPSC, MANPSD

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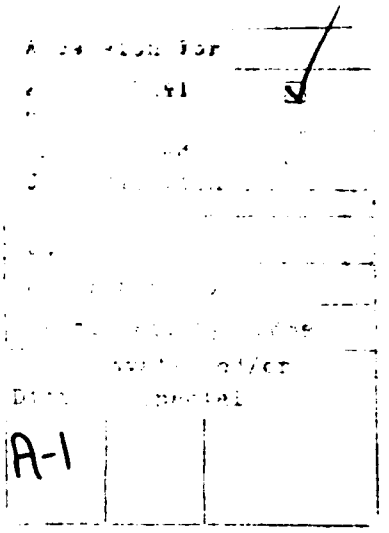
TECHNOLOGY INSERTION-ENGINEERING SERVICES
PROCESS CHARACTERIZATION
TASK ORDER NO. 1

VOLUME VII
WR-ALC

CONTRACT SUMMARY REPORT
25 SEPTEMBER 1989



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LIST OF ACRONYMS AND ABBREVIATIONS

AFLC	AIR FORCE LOGISTICS COMMAND
AFLC/MA	AIR FORCE LOGISTICS COMMAND DIRECTORATE OF MAINTENANCE
AGMC	AEROSPACE GUIDANCE AND METROLOGY CENTER
ALC	AIR LOGISTICS CENTER
ATE	AUTOMATIC TEST EQUIPMENT
CAD	COMPUTER-AIDED DESIGN
CSR	CONTRACT SUMMARY REPORT
FSR	FOCUS STUDY RECOMMENDATION
FY	FISCAL YEAR
GRU	GYROSCOPIC REFERENCE UNIT
IE	INDUSTRIAL ENGINEER
JON	JOB ORDER NUMBER
LIFT	LOGISTICS IMPROVEMENT OF FACILITIES AND TECHNOLOGY
MDC	MCDONNELL DOUGLAS CORPORATION
MDGATS	MULTIPLE DISPLACEMENT GYRO AUTOMATED TEST SYSTEMS
MDMSC	MCDONNELL DOUGLAS MISSILE SYSTEMS COMPANY
MISTR	MANAGEMENT OF ITEMS SUBJECT TO REPAIR
MTBF	MEAN TIME BETWEEN FAILURES
MTTR	MEAN TIME TO REPAIR
NSN	NATIONAL SERIAL NUMBER
P/N	PART NUMBER
PAC	PRODUCTION ACCEPTANCE CERTIFICATION
PCN	PART CONTROL NUMBER
PDM	PROGRAM DEPOT MAINTENANCE
PRAM	PRODUCTIVITY, RELIABILITY, AVAILABILITY AND MAINTAINABILITY
QFP	QUICK FIX PLAN
RCC	RESOURCE CONTROL CENTER
ROI	RETURN ON INVESTMENT

ROM	ROUGH ORDER MAGNITUDE
SOW	STATEMENT OF WORK
TI-ES	TECHNOLOGY INSERTION-ENGINEERING SERVICES
TO	TASK ORDER
TQM	TOTAL QUALITY MANAGEMENT
UDOS 2.0	UNIVERSAL DEPOT OVERHAUL SIMULATOR 2.0
WCD	WORK CONTROL DOCUMENT
WIP	WORK IN PROCESS
WR-ALC	WARNER ROBINS AIR LOGISTICS CENTER

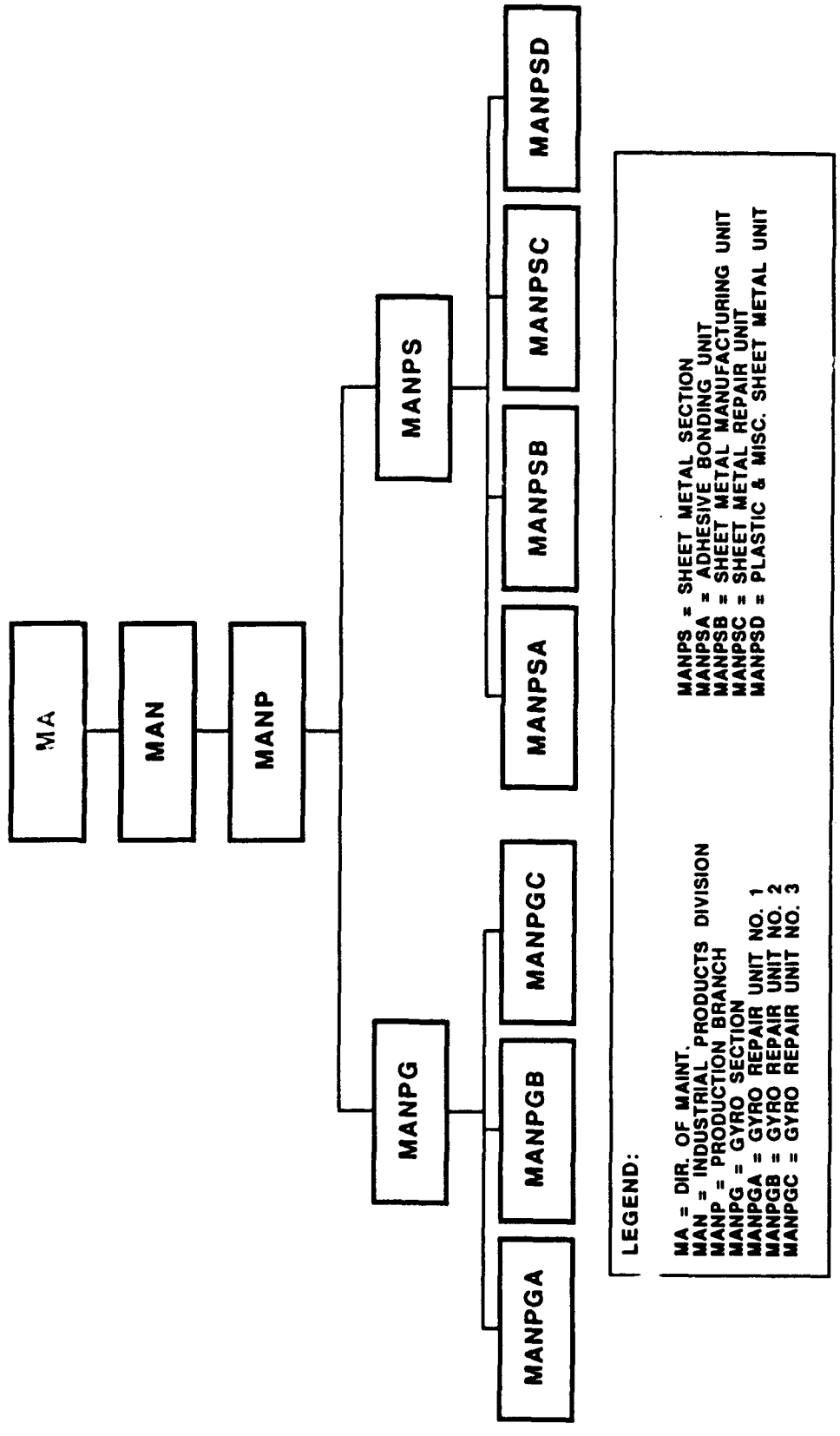
WR-ALC CONTRACT SUMMARY REPORT

10.0 WARNER ROBINS AIR LOGISTICS CENTER (WR-ALC)

During the third quarter of FY 89, McDonnell Douglas Missile Systems Company (MDMSC) completed process characterization of seven Resource Control Centers (RCCs) within the Industrial Product Division (MAN) at WR-ALC, Robins Air Force Base, Warner Robins, Georgia. The Industrial Product Division is responsible for performing depot level repair and modification in support of major aircraft weapon systems including C-141, C-130 and F-15 aircraft and gyroscopes. The process characterization was performed as a part of Task Order (TO) No. 1 of the Air Force Technology Insertion-Engineering Services (TI-ES) program.

The seven WR-ALC RCCs, MANPSA, MANPSB, MANPSC, MANPSD, MANPGA, MANPGB, and MANPGC were selected by the Air Force for process characterization, and are depicted in Figure 10.0-1, these RCCs are currently meeting production schedules. Simulation modeling was executed with surge factor for the above seven RCCs. It was determined that RCCs MANPSA and MANPSC will have problems in fulfilling surge requirements. Additional allocation of manpower, WG-10 for MANPSA and WG-10 and WG-8 for MANPSC, will be required to fulfill the surge requirement.

MDMSC selected the repair processes within the RCC to be modeled based on the 80/20 workload concept. The repair processes were modeled for two purposes; first, to establish an operational baseline from which improvements can be measured and second, to identify technological improvements to assist WR-ALC in meeting its commitments. During this process MDMSC observed and compared ALC's repair process to private industry. The mechanics are doing their best, with the limited tools they have, to meet schedules. Most first line supervisors are promoted from mechanics level and they are very knowledgeable of their end item and repair process. Repair of end items involves extensive manual processes; some of which could be automated. For example, deburring and hand forming can be automated by utilizing state-of-the-art technology such as the fluid press and five axis deburring machine.



WR-ALC RCC PROCESS CHARACTERIZATION COVERAGE

FIGURE 10.0-1

MDMSC representatives were well received by WR-ALC management and line workers during process characterization. Much of the information obtained was jointly developed by MDMSC/Air Force personnel. A briefing on the intent of the TI program was given to ALC manufacturing personnel by MDMSC representatives and was well received. WR-ALC mechanics were very cooperative in sharing and providing information for the success of process characterization. During historical data collection we found the practice of gang stamping of WCDs prevalent and found historical data for process characterization being kept for temporary and manufacturing RCC unusable.

Process characterization revealed that opportunity for improvement exists at all RCCs. After review of the opportunity improvements recorded by MDMSC during process characterization, it was discovered that many of the areas had already been addressed by WR-ALC management. The focus study and quick fix areas which were defined and pursued are described in paragraphs 10.1 through 10.7.4 of the Contract Summary Report (CSR) and in paragraphs 10.0 through 10.7.6 of the Quick Fix Plan (QFP).

This CSR presents an overview of the MDMSC effort and details recommendations to improve WR-ALC performance. Table 10.0-1 summarizes the recommended focus studies and Table 10.0-2 summarizes the quick fixes for WR-ALC. Quick fixes are described under separate cover in the QFP.

The seven RCCs characterized and modeled are in the Industrial Products Division (MAN) and consist of three MANPG Gyro Section units and four MANPS Sheet Metal units.

The three MANPG RCCs responsible for aircraft navigational gyroscope repair are:

- MANPGA, responsible primarily for repair of miniature rate gyros.

- MANPGB, responsible for various vertical, two axis displacement gyros repair and flight data instruments.

WR-ALC FOCUS STUDY RECOMMENDATION SUMMARY

TABLE 10.0-1

MDMSC RECOMMENDATION	IMPACT	ANNUAL BUDGET SAVINGS	COST AVOIDANCE			INVESTMENT COST
			FLOW TIME REDUCTION	WIP INVENTORY REDUCTION*	FLOOR SPACE REDUCTION	
COMBINE RCCS MANPGA, MANPGB, AND MANPGC GYRO ROTOR ASSEMBLY TO A COMMON LINE FLOW	DIRECT LABOR SAVINGS, ENVIRONMENTAL IMPROVEMENT, FLOOR SPACE REDUCTION	$ 447,873	N/Q UNTIL AFTER FOCUS STUDY	N/Q UNTIL AFTER FOCUS STUDY	N/Q UNTIL AFTER FOCUS STUDY	$ 25,000
REDESIGN AND MODIFICATION OF C-141 AILERON CHECK FIXTURE (MANPSA)	DIRECT LABOR SAVINGS	$ 460,414	0 DAYS	$ 0	0 SQ. FT.	$1,140,230
REDESIGN AND MODIFICATION OF C-141 PETAL DOOR JIGS (MANPSA)	DIRECT LABOR SAVINGS	$ 286,080	0 DAYS	$ 0	0 SQ. FT.	$1,140,230
REDESIGN AND MODIFICATION OF C-141 AFT COWL JIGS (MANPSC)	DIRECT LABOR SAVINGS	$ 537,316	0 DAYS	$ 0	0 SQ. FT.	$1,140,230
[ALTERNATE FOCUS STUDY] C-141 AILERON, PETAL DOOR, AND AFT COWL TOOLING (MANPSA, MANPSC)	DIRECT LABOR SAVINGS	$1,283,861	0 DAYS	$ 0	0 SQ. FT.	$3,080,691
ALTERNATE TOTALS		$1,731,734A				$3,105,691A
TOTALS		$1,731,683		$ 4,037,000		$3,445,690

NOTES: * WIP INVENTORY REDUCTION = $\frac{\text{\# OF FLOW DAYS REDUCED}}{\text{365DAYS}}$ X (ASSET $ VALUE) X (YEARLY PRODUCTION RATE)

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WR-ALC QUICK FIX RECOMMENDATION SUMMARY

TABLE 10.0-2 (SHEET 1 OF 2)

MDMSC RECOMMENDATION	IMPACT	ANNUAL BUDGET SAVINGS	COST AVOIDANCE			INVESTMENT COST
			FLOW TIME REDUCTION	WIP INVENTORY REDUCTION*	FLOOR SPACE REDUCTION	
DEVELOP MECHANICS HANDBOOK (MANPSA, PSB, PSC, PSD)	DIRECT LABOR SAVINGS	$1,598,706	0 DAYS	$ 0	0 SQ. FT.	$ 28,000
PROVIDE PICTORIAL DRAWINGS IN WCDS (MANPSA, PSB, PSC, PSD)	DIRECT LABOR SAVINGS	INCLUDED IN ABOVE	0 DAYS	$ 0	0 SQ. FT.	$ 20,000
MECHANICS TOOL SET (MANPSA, PSB, PSC, PSD)	DIRECT LABOR SAVINGS	$ 476,679	0 DAYS	$ 0	981 SQ. FT.	$ 95,336
COBALT-TIPPED DRILL BITS (MANPSA, PSB, PSC, PSD)	DIRECT LABOR SAVINGS	$ 476,679	0 DAYS	$ 0	0 SQ. FT.	$ 10,000
ELIMINATE CLEAN ROOM GARB (MANPGA)	DIRECT LABOR SAVINGS	$ 436,977	0 DAYS	$ 0	0 SQ. FT.	$ 16,600
RADOME SUPPORT FIXTURE (MANPSD)	DIRECT LABOR SAVINGS	$ 248,075	0 DAYS	$ 0	0 SQ. FT.	$ 40,000
VENT MASS SPECTROMETERS (MANPGA)	DIRECT LABOR SAVINGS & ENVIRONMENTAL IMPROVEMENT	$ 101,152	0 DAYS	$ 0	0 SQ. FT.	$ 4,000
CERTIFY BRAZING MECHANIC (MANPSA)	DIRECT LABOR SAVINGS & INVENTORY REDUCTION	$ 60,691	UNDERWAY	-	-	UNDERWAY
RELOCATE BOND MECHANICS (MANPSA)	DIRECT LABOR SAVINGS	$ 57,530	0 DAYS	$ 0	0 SQ. FT.	NEGLIGIBLE
IMPROVE TAPE REBONDING (MANPGB)	DIRECT LABOR SAVINGS	$ 40,244	0 DAYS	$ 0	0 SQ. FT.	$ 2,562
TOTALS						

NOTES: * WIP INVENTORY REDUCTION = $\frac{\text{\# OF FLOW DAYS REDUCED}}{\text{365DAYS}}$ X (ASSET $ VALUE) X (YEARLY PRODUCTION RATE)

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WR-ALC QUICK FIX RECOMMENDATION SUMMARY

TABLE 10.0-2 (SHEET 2 OF 2)

MDMSC RECOMMENDATION	IMPACT	ANNUAL BUDGET SAVINGS	COST AVOIDANCE			INVESTMENT COST
			FLOW TIME REDUCTION	WIP INVENTORY REDUCTION*	FLOOR SPACE REDUCTION	
FIXTURE INDUCTION MACHINE (MANPGA, PGB, PGC)	DIRECT LABOR SAVINGS	$ 39,266	0 DAYS	$ 0	0 SQ. FT.	$ 10,690
AILERON TAB HINGE LOCATOR TOOL (MANPS)	DIRECT LABOR SAVINGS	$ 15,963	0 DAYS	$ 0	0 SQ. FT.	$ 7,500
NEWSPAPER ROLLING CUTTER TOOL (MANP)	DIRECT LABOR SAVINGS	$ 15,173	0 DAYS	$ 0	0 SQ. FT.	$ 1,600
RELOCATE MA[illegible]ROMETERS (MANPGB)	DIRECT LABOR SAVINGS & ENVIRONMENTAL IMPROVEMENT	$ 11,977	0 DAYS	$ 0	0 SQ. FT.	$ 3,759
IMPROVE DRIFT DEC[illegible]IS (MANPGC)	DIRECT LABOR SAVINGS	$ 11,519	0 DAYS	$ 0	0 SQ. FT.	$ 10,000
IMPROVE BEARING HANDLING (MANPGA, PGB, PGC)	MATERIAL SAVINGS	$ 6,600	0 DAYS	20% YIELD IMPROVEMENT	0 SQ. FT.	$ 5,264
RE-EVALUATE DIAGNOSTIC CHECKS (MANPGA, PGB, PGC)	DIRECT LABOR SAVINGS	$ 4,191	0 DAYS	$ 0	0 SQ. FT.	NEGLIGIBLE
PROVIDE LEVEL SUPPORT TABLES (MANPSA)	DIRECT LABOR SAVINGS	$ 2,008	0 DAYS	$ 0	0 SQ. FT.	$ 1,500
COMBINE AFT COWL REPAIR OPERATIONS (MANPSA)	DIRECT LABOR SAVINGS	N/Q	0 DAYS	$ 0	0 SQ. FT.	NEGLIGIBLE
ALODINE BRUSH CAPABILITY (MANPSD)	FLOW TIME REDUCTION	EXISTING ALC STUDY	0 DAYS	$ 0	0 SQ. FT.	NEGLIGIBLE
TOTALS		$3,678,424				$256,811

NOTES: * WIP INVENTORY REDUCTION = $\frac{\text{\# OF FLOW DAYS REDUCED}}{\text{365DAYS}}$ X (ASSET $ VALUE) X (YEARLY PRODUCTION RATE)

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- MANPGC, responsible for directional gyroscope systems and rate switching gyros. There is close interaction and interdependence between these MANPG section RCCs.

Nine improvement opportunities, consisting of one focus study and eight quick fixes, relating to gyroscope repair were selected as the focus of the MANPG Gyro Section TI-ES Program activities. The focus study, titled Combine Gyro Rotor Assembly Repair to a Common Line Flow and detailed in paragraph 10.1.4, proposes investigation of efficient methods to reorganize RCCs MANPGA, MANPGB and MANPGC gyro rotor repair to improve process flow time while improving manpower, equipment, material handling and floor space utilization. An estimated annual cost savings of $447,873 may be realized by implementation of this focus study within MANPG.

The eight quick fixes applicable to RCCs MANPGA, MANPGB and MANPGC are summarized below with their respective estimated cost savings.

- Eliminate Clean Room Garb Requirements In MANPGA
  Proposes that an evaluation of Technical Order requirements may determine the feasibility to eliminate non-productive Class 100,000 clean room "suits" for most, if not all, personnel working within the RCC. Yearly savings of $436,977 may be realized.

- Vent the Vacuum Pumps of the Mass Spectrometers in MANPGA
  Aimed at improving throughput of gyro leak checking operations by modifying the exhaust venting and utilizing currently available equipment resources. Yearly savings of $101,152 may be realized.
- Improve Gimbal/Spin Bearing Handling in MANPGA, MANPGB and MANPGC
  Proposes establishing better material handling techniques to increase the yield of bearing refurbishment operations. Yearly savings of $6,600 may be realized.

- Improve Fixturing the Induction Machines in MANPGA, MANPGB and MANPGC

  Proposes how safety and product quality improvements can be derived from a consistent fixturing methodology for gyro desoldering activities. Yearly savings of $39,266 may be realized after implementation.

- Re-evaluate Need for Diagnostic Checks in All MANPG RCCs

  Proposes that based on historical E046B data, when wheel repair occurrence factors of 90% and greater are noted, a cost benefit can be derived by eliminating the limited value diagnostic testing for certain gyroscopes. Yearly savings for the 74146A gyro alone could be $4,191.

- Improve Bonding of PCN 20012A Tapes in MANPGB

  Proposes that the acquisition of a thermo-compression bonder could allow rebonding of separated, undamaged tape which is currently scrapped. Yearly savings of $40,244 may be realized.

- Relocate Mass Spectrometers in MANPGB

  Proposes to eliminate nonproductive transit times away from the gyro seal repair area. Current concerns of potential air contamination by the mass spectrometers could be solved by improved ventilation and/or duct work if necessary. Yearly savings of $11,977 may be realized.

- Improve Random Drift Decisions in MANPGC

  Proposes implementation of a decision panel device which should minimize the testing of defective gyros for a prolonged time. Yearly savings of $11,519 may be realized after implementation.

The four MANPS RCCs responsible for repair of major sheet metal component assemblies for the C-130, C-141 and the F-15 aircraft are:

- MANPSA, responsible for the sheet metal bonding repair of the C-141 petal doors, access doors, ailerons, wing leading edges, horizontal stabilizer leading edges and the composite repair of the F-15 speed brake.

- MANPSB, responsible for the manufacture of new parts required for repair by other RCCs to support the C-130, C-141 and the F-15 repair effort.

- MANPSC, responsible for the bonding and conventional sheet metal repair of the C-130 elevator, flaps, and scoop, and the C-141 aft cowling and thrust door.

- MANPSD, responsible for the conventional sheet metal, fiberglass, bonded honeycomb, and composite repairs of the F-15A/F-15B canopies, F-15 radome, C-130E/C-130A radomes, C-141 engine exhaust nozzle and the C-141 wing leading edges.

Sixteen improvement opportunities, consisting of four focus studies and twelve quick fixes, relating to sheet metal repair, were selected as the focus of the MANPS Sheet Metal Section TI-ES Program activities. The focus study, titled C-141 Aileron, Petal Door, and Aft Cowl Tooling, and detailed in paragraph 10.6.5, proposes combining Focus Study Recommendation (FSR) No. 2, FSR No. 3 and FSR No. 4 as the most cost effective way to rework/modify existing tools and add jigs to boost throughput to the desired level. The estimated annual cost savings of $1,283,861 may be realized by implementation of this focus study within MANPS.

The 12 quick fixes applicable to RCCs MANPSA, MANPSB, MANPSC, and MANPSD are summarized below with their respective estimated cost savings.

- Develop a Mechanic's Handbook for Each Repaired Assembly which would compliment and supplement the Technical Orders and document all major steps and techniques of each repaired assembly unit. The manual would be invaluable to new or less experienced mechanics in a rapid build-up surge or war-time readiness situation or where a production rate increase would be necessary such as the present F-15 wing repair effort. Yearly savings of $1,598,706 may be realized, as shown in Table 10.4.1-1.

- Implement Program for the Mechanic to Buy and Maintain Own Handtools to eliminate/reduce the number of tools/boxes/stands, tool crib manpower and purchasing expense. The plan will provide the necessary tools to work with and make the worker responsible for the tool inventory and the replacement of broken handtools. Yearly savings of $476,679 may be realized, as shown in Table 10.4.2-1.

- Move Bond Mechanics Closer to the Autoclaves, thereby reducing time lost by going back and forth to the mechanics home station. Yearly savings of $57,730 may be realized.

- Provide Level Aileron Support Tables to eliminate the time needed to make existing tables level. Yearly savings of $2,008 may be realized.

- Provide Pictorial Drawings With the Existing Workbooks(WCDs) to assist the worker to better understand the required task and to help train others in a surge or war-time emergency situation. Yearly savings for this quick fix are included in the Mechanic's Handbook Quick Fix.

- Design/Build An Aileron Tab Hinge Locator to aid the mechanic in the replacement and correct shimming of the aileron tab hinge fittings on the C-141 aileron rear beam. This is difficult to do using the tab assembly as a tool because the tab leading edge is in the way. Yearly savings of $15,963 may be realized.

- Design/Build a Type of a Newspaper Clipping Cutter for the mechanic to use to assist in the cutting of thin (.005) skins on the C-141 horizontal stabilizer leading edges. This tool is similar to a tool used to cut wood veneers. This new tool will replace the current cumbersome way of having to use unwieldy type makeshift tools such as a can opener. Yearly savings of $15,173 may be realized.

- Certify the Mechanic Repairing the C-141 Horizontal Stabilizer leading edges on the use of an ohmmeter and brazing units to check the continuity of the wiring and the mesh heating elements. This will relieve the mechanic from making at least four trips to the back shop for repair verification. Yearly savings of $60,691 may be realized.

- Provide Holding/Support Fixtures for All Radomes to hold the radome on its side and to allow the radome to be rotated. This method would be similar to the holding fixture currently being used on the C-141 nozzle repair effort. This new support stand will provide better access and less worker strain. Yearly savings of $248,075 may be realized.

- Brush Alodine Treatment Capability for Building 603 to eliminate the transportation of parts to Building 180 about two miles away. This is currently under study for both a temporary and a permanent solution to the situation. (Existing study-no cost savings available).

- Combine Repair Operations for the C-141 Aft Cowl Door to complete the entire repair/rework effort in one work area rather than the current three. This will eliminate duplicity of effort and decrease the flow time for the unit by the amount of time required to move from one mechanic to another (not quantifiable).

- Make Available Cobalt-Tipped Drill Bits, or Equivalent, in lieu of resharpened drill bits, for the mechanic's use to drill out aluminum rivets and other type fasteners such as steel bolts and blind steel rivets. Yearly savings of $476,679 may be realized.

AFLC may realize an estimated $5,410,158 in recurring savings if all of the focus studies and all the quick fix plan opportunities are incorporated.

10.1 MANPGA ANALYSIS AND FOCUS STUDY RECOMMENDATIONS

The MANPGA RCC, along with its sister Gyro Section RCCs MANPGB and MANPGC, are responsible for the overhaul and test of various miniature rate, vertical, two axis displacement gyroscopes (gyros) and flight data instruments. The workload within MANPGA consists of MISTR and exchangeables.

The MDMSC team has developed a good working relationship with the Gyro Unit No. 1 repair operations personnel. Gyro personnel were instrumental in the success of the site survey tasks such as data collection, operation profiles, shop floor interviews and review of facility layouts. This provides the basis to characterize the operation of MANPGA and allows for the identification of process improvement opportunities. MDMSC appreciates the excellent cooperation received from the entire WR-ALC team.

During initial characterization of the MANPGA RCC, a total of 13 potential improvement opportunities were identified (reference MANPGA Database Documentation Book, Potential Improvement Opportunities section). After review of this original set of opportunities by the MDMSC/WR-ALC team, six improvement opportunities were selected to be pursued as the focus of the TI-ES Program activities relating to MANPGA.

The first improvement opportunity, a focus study, titled Combine RCCs MANPGA, MANPGB and MANPGC Gyro Rotor Assembly Repair to a Common Line Flow recommends inserting a Just-In-Time (JIT) cellular manufacturing environment to improve coordination of MANPG gyro rotor repair activities and substantially reduce flow times and resource requirements. Production/process flexibility and quality will improve as well. This focus study is presented in detail in paragraphs 10.1.4 through 10.1.4.4.

The proposed focus study will provide a detailed summary of the expected cost savings/benefits to MANPGA repair/remanufacturing operations. Upon completion of the focus study, the As-Is baseline information will be used to

define discrete quantitative as well as qualitative changes that can be made to improve the following:

- Resource Utilization
- Cost
- Quality
- Product Throughput
- Process Flow Time

Five of the improvement opportunities selected will be presented as quick fixes and are summarized below.

- Eliminate Clean Room Garb Requirements In MANPGA
  Proposes that an evaluation of Technical Order requirements may determine the feasibility to eliminate non-productive Class 100,000 clean room "suits" for most, if not all, personnel working within the RCC.

- Vent the Vacuum Pumps of the Mass Spectrometers in MANPGA
  Aims at improving throughput of gyro leak checking operations by modifying the exhaust venting and utilizing available equipment resources.

- Improve Gimbal/Spin Bearing Handling in MANPGA, MANPGB and MANPGC
  Proposes establishing better material handling techniques to increase the yield of bearing refurbishment operations.

- Improve Fixturing the Induction Machines in MANPGA, MANPGB and MANPGC
  Proposes how safety and product quality improvements can be derived from a consistent fixturing methodology for gyro desoldering activities.

- Re-evaluate Need for Diagnostic Checks at All MANPG RCCs
  Proposes that based on historical E046B data, when wheel repair occurrence factors of 90% and greater are noted, a cost benefit can be

derived by eliminating the limited value diagnostic testing for certain gyroscopes.

These quick fixes offer benefits to MANPGA in terms of quality, time and cost and are described in detail in the WR-ALC Quick Fix Plan, MANPGA Quick Fix opportunities section.

The remainder of the original MANPGA improvement opportunities are presented as other observations and are described in paragraph 10.1.5 of this document.

10.1.1 Description of Current Operations

MANPGA is an RCC under the MANPG section of the Industrial Products Division (MAN) at WR-ALC. MANPGA is located in a Class 100,000 clean room area in Building 158. The primary workload is MISTR work. It consists of test and repair of gyroscopes. Most of the effort is on miniature rate gyros but also includes a vertical and directional gyroscope repair. The workload has been decreasing due primarily to the age of the product under repair.

MISTR workload within MANPGA represents greater than 98% of the workload. The RCC tests and repairs in excess of 12,000 units annually shared amongst the three Gyro Section RCCs. Table 10.1.1-1 depicts the PCNs involved in the FY 88 80/20 workload analysis. The process of inducting, repairing, and testing

MANPGA GYRO SHOP FY 88 WORKLOAD

TABLE 10.1.1-1

REPRESENTATIVE GYRO FAMILY PCN	FY 88 INDUCTIONS				TOTALS
	1ST QTR	2ND QTR	3RD QTR	4TH QTR	
74010A	265	265	265	265	1060
74074A	131	91	14	24	260
74103A	219	122	122	122	585
74126A	347	347	347	347	1388

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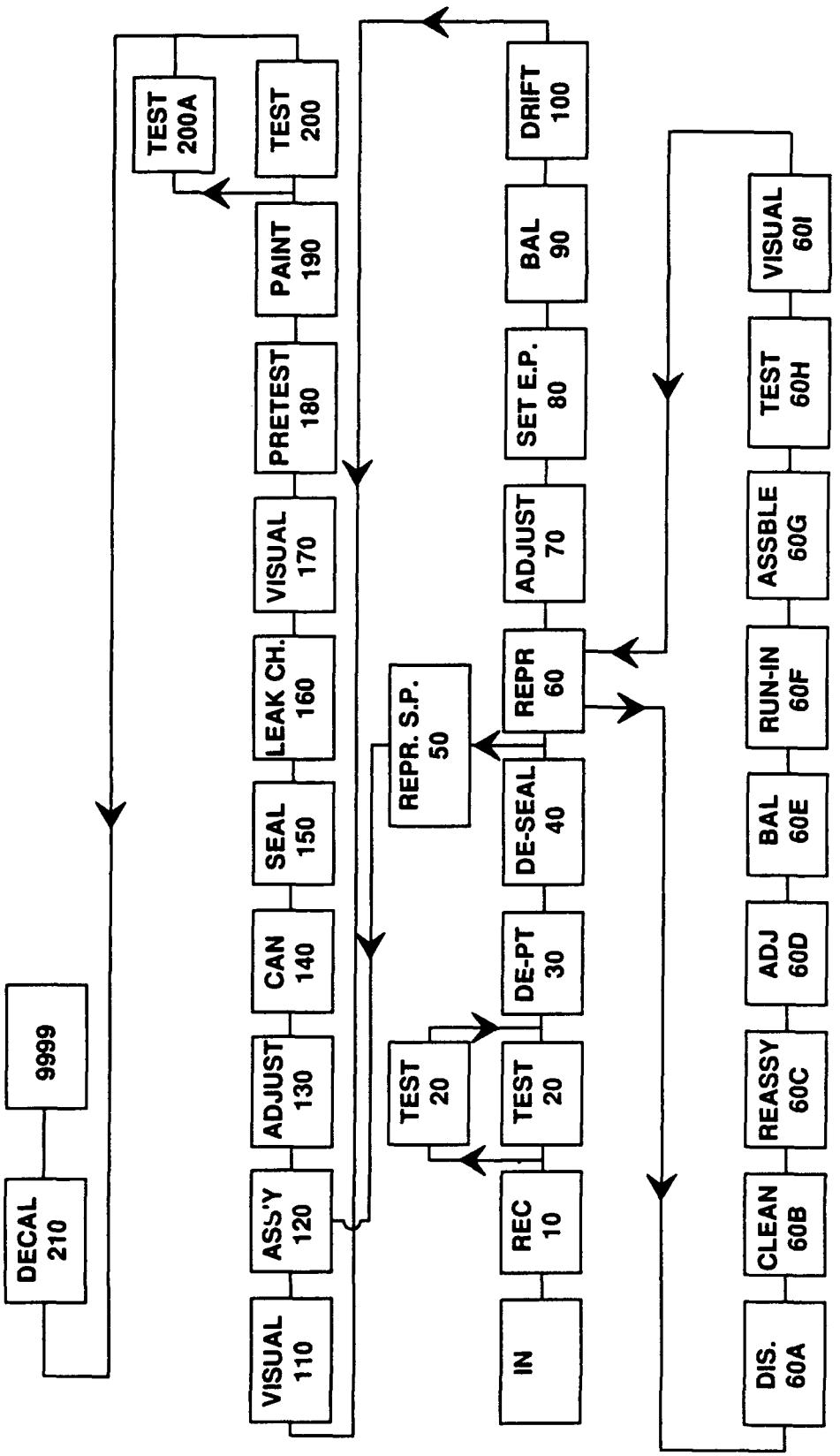
of gyros is compatible with like operations in private industry. Figure 10.1.1-1 is a general process flow chart of gyro repair operations most common within RCC MANPGA.

MANPGA equipment consists mainly of individual workbench stations, vacuum and circulating ovens, leak detecting stations, and many manual and semi-programmable test stands. Most of the tooling is standard precision hand tools furnished to the technical operators in complete kit sets. Each separate PCN model does require some special tooling but little is complex enough to require concern in this study. The circulating and vacuum ovens are minor adaptions of standard units. The leak detection equipment are standard catalog items such as Veeco or Varian, then adapted to specific model gyros or families of gyros. The test sets and stands, except for the Contraves rate test stations, are of an age consistent with the product design age. It is doubtful that the test sets can be properly supported much longer. The Contraves test stations are of a more recent design than the rate test stations and are closer to state of the art. They are manually programmable and are capable of testing a large variety of gyroscopes. A listing of major equipment for MANPGA can be found in the equipment profile list in section 5.0 of the DDB.

The repair process technologies within MANPGA consist of defining the gyroscope malfunction causes, repairing as required, and retesting to verify the repair. The gyros are pretested to identify malfunctions, torn down and repaired as required to technical overhaul manuals. Repair is generally accomplished through replacement of worn and/or defective piece parts. The rebuild and acceptance testing is also directed by Technical Orders and test specifications. Some mandatory replacement of high failure items are directed by Technical Orders to extend MTBF. Precision bearing and miniature slip rings/brushes are examples of some 100% replacement parts.

The first quick fix opportunity was observed where all personnel entering MANPGA are required to "suit up" with clean room garb prior to RCC repair activities. MDMSC proposes that an evaluation of Technical Orders may



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MANPGA RATE GYRO PROCESS FLOW CHART
FIGURE 10.1.1-1

determine the feasibility of eliminating the clean room "suits" for personnel working within the RCC. This problem is addressed in detail and presented in paragraph 10.1.1 of the MANPGA QFP.

The first step in the gyro repair process is the manual desoldering of the sealed gyro case (cover) to allow removal of the gyro for repair. Shop floor interviews and observations indicate a quick fix opportunity exists to provide proper fixturing during gyro covers unsealing operations utilizing the induction heater machine. This opportunity is presented in detail in paragraph 10.1.4 of the MANPGA QFP.

The metallic gyro cover halves are thoroughly depainted by plastic bead blasting and cleaned. Cost efficiencies and improved throughput could be achieved if certain operations were performed in cost-effective lot quantities with egronomically designed tools and fixtures (addressed in Focus Study No. 1 of AGMC CSR Volume II). This Focus Study Recommendation (FSR) will also define opportunities for enhanced GRU unseal, depaint, seal and leak check product quality through the utilization of an improved soldering/sealing system. MDMSC recommends that WR-ALC participate with AGMC in the conduct of the FSR to allow realization of consistent technology insertion of potential improvements at both AFLC sites.

Another quick fix opportunity identified is to better utilize the mass spectrometers for leak checking gyros. Improved throughput could be attained by modifying the exhaust venting of the mass spectrometers vacuum pump system. This opportunity, titled Vent Vacuum Pumps of Mass Spectrometers is addressed in detail and presented in paragraph 10.1.2 of the MANPGA QFP.

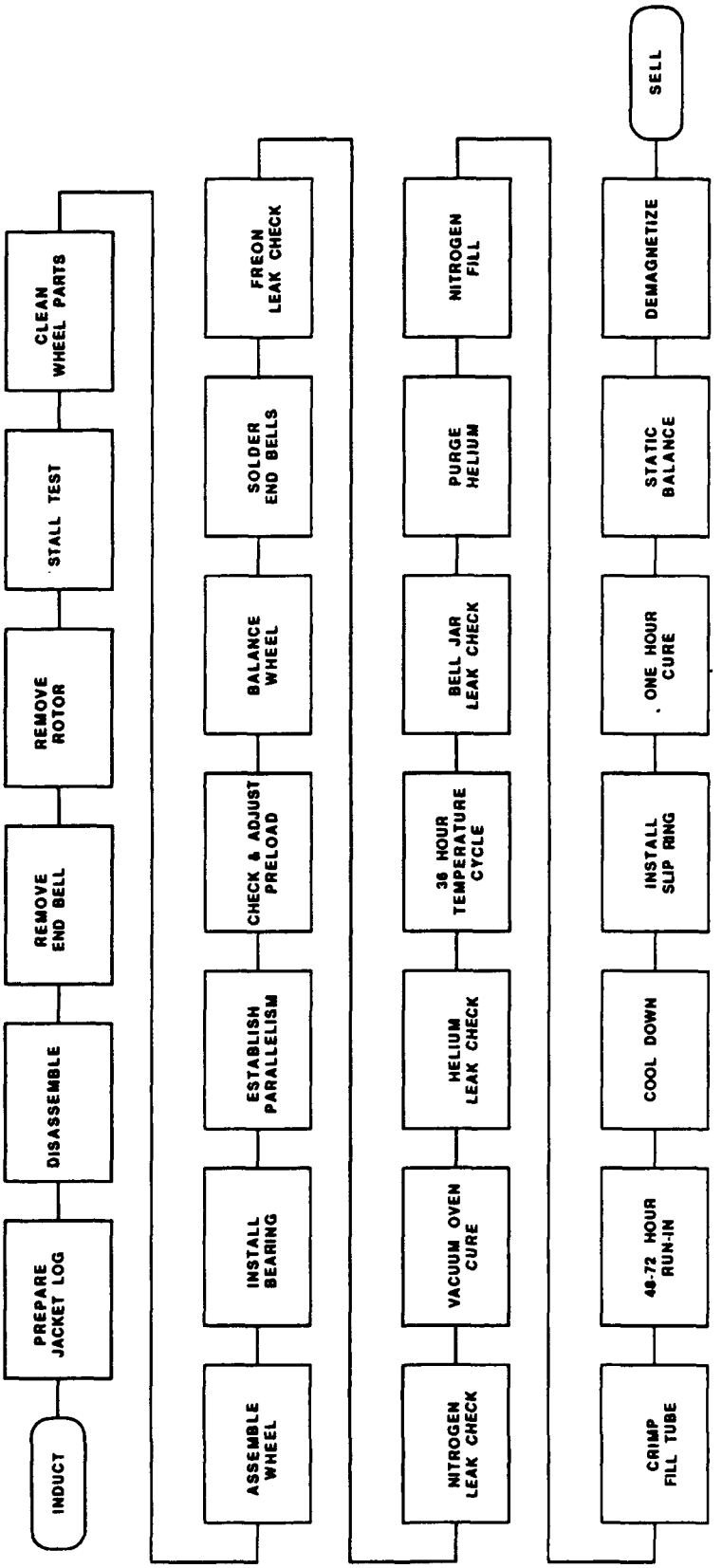
In depot repair of gyroscopes, most of the time is spent in testing. Units are diagnostically tested, faulty components replaced and functionally tested. Repair is usually performed by a single technician at a bench-type laminar flow booth work station. Bench repair does not require complex routings and is dedicated to a particular product.

A quick fix opportunity to improve labor manpower utilization and throughput was observed on PCN 74146A gyro diagnostic testing procedures. Historical wheel repair occurrence factors indicate little benefit is gained from performing initial diagnostic tests. This opportunity is addressed in detail in paragraph 10.1.5 of the MANPGA QFP.

After repair and calibration, resealing of the gyro covers is again accomplished by a manual soldering process. The next major process involves the technician pressurizing the gyro with a gas, immersing it into a liquid, and performing a gross leak check by a bubble test. If a leak is detected, the unit must be resealed additionally in the area of the visible leaks. After subsequent recycles and successful completion by the gross leak bubble test, the gyro seal integrity is final functional tested on a Veeco vacuum leak detection system.

Conducted in parallel with gyro repair activities, all wheel (gyro rotor) repair process technologies are routinely batch processed in quantities of 10 to 20 units. Figure 10.1.1-2 is a general process flow chart of MANPGA wheel repair operations. During process characterization efforts in all three MANPG RCCs, it was noted that each unit is responsible for several gyro rotor PCNs and performs the necessary repair processes according to individual line and/or technician availability. Focus Study No. 1, will address this problem by determining the feasibility of combining RCCs MANPGA, MANPGB and MANPGC Gyro Rotor Assembly Repair to a Common Line Flow. Improved coordination of MANPG gyro rotor repair activities will substantially reduce flow times and resource requirements. Table 10.1.1-2 summarizes the FY 88 MANPG gyro section workload and quantifies the amount of gyro rotor rebuild activities currently spread throughout all three RCCs. This focus study is presented in detail in paragraphs 10.1.4 through 10.1.4.4.

Material handling in MANPGA is mostly accomplished by the repair operator hand carrying the items between stations. The gyroscopes are small, weighing from ounces to a few pounds. Units are repaired by a single mechanic rather than by line flow process. The one exception to this method is rotor repair,



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MANPGA GYRO ROTOR PROCESS FLOW CHART
FIGURE 10.1.1-2

MANPG GYRO SHOP FY 88 WORKLOAD

TABLE 10.1.1-2

REPRESENTATIVE GYRO FAMILY PCN	FY 88 INDUCTIONS				TOTALS
	1ST QTR	2ND QTR	3RD QTR	4TH QTR	
74010A	265	265	265	265	1060
74074A	131	91	14	24	260
74103A	219	122	122	122	585
74126A7	347	347	347	347	1388
74051A	975	966	921	927	3789
06121A	149	149	149	149	596
74061A	343	343	343	343	1372
74063A	244	244	244	244	976
74148A	255	255	255	255	1020
74148A	175	175	175	175	700
74149A	169	169	169	169	676
					12,422

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which are repaired in groups rather than one at a time. The repair is still accomplished by a mechanic, not a line, but an operation is completed on multi assemblies before moving to the next operation.

A quick fix opportunity, involving wheel repair operations, is titled Improve Gimbal/Spin Bearing Handling. MDMSC observed that establishing improved material handling techniques would increase the yield of bearing refurbishment operations. This quick fix is presented in detail in paragraph 10.1.3 of the MANPGA QFP.

The facility layout drawing of the MANPGA sections of Building 158 does represent the As-Is condition of the facility at the time of the study. Since that time, the GG1111 rate gyro has been inducted for repair. The area is now under rearrangement to accommodate the new unit.

Storage is accomplished on shelved hand trucks between aisles on the repair floor. The items for repair are received, logged in, and placed on the storage trucks for pretest. After pretest, the items are returned to the truck to wait the availability of a mechanic. The item is repaired and calibrated then returned to the truck or another truck for testing and shipment.

MANPGA has a stable work force with little variance. The work force is comprised of instrument mechanics, three supervisors, a clerk, and a senior supervisor. The following is a breakdown of the mechanics within MANPGA.

Skill Code	Skill Level	Quantity	Experience
WG 3359	G-10	3	36.7 yrs.
WG 3359	G-09	45	18.7 yrs.
WG 3359	G-07	16	6.4 yrs.
WG 3359	G-04	1	7.0 yrs.

It is to be noted that the work force is shared between the gyro RCCs as workloads vary. A major concern is availability of trained instrument mechanics if increased workload was demanded. The age of the work force should also be

of a concern. Experience is very high but natural attrition is reducing the numbers faster than training is furnishing younger mechanics. Surge conditions would be impacted by this constraint. Figure 10.1.1-3 depicts the typical organization of a MANPG RCC.

10.1.2 Statistical System Performance Measures

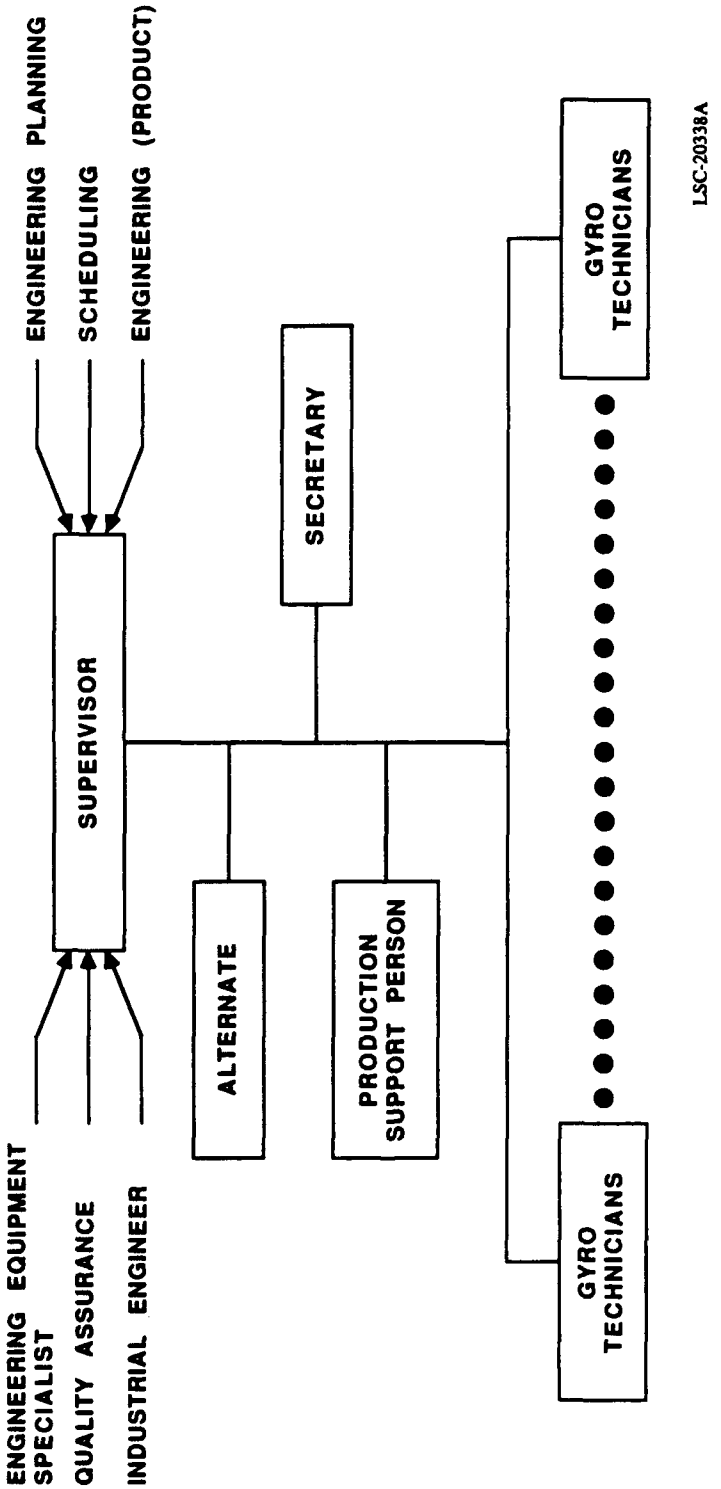
MANPGA repairs and tests miniature rate gyros and also a vertical and directional gyro. The WR-ALC/MDMSC TI-ES team selected PCNs 74010A, 74074A, 74103A and 74126A to represent a generic family of gyros commonly overhauled in this RCC. The team's process characterization of these gyros included gathering data via:

- Interviews with ALC/RCC personnel
- WCD historical information with scheduling personnel assistance
- Maintenance and production interviews concerning equipment MTBF and MTTR

This profile data sheet information was then transferred to personal computer files using a Lotus 1-2-3 database storage system. After data verification, flat files for this RCC were generated. Simulation runs were then executed utilizing UDOS 2.0.

The WR-ALC/MDMSC TI-ES team, along with an AFLC representative, performed a statistical comparison of the UDOS 2.0 model simulation outputs for the FY 88 MANPGA repair process. The validation was performed by comparing average simulated to average historical flow times, and average simulated throughput to FY 88 throughput. The WR-ALC/MDMSC team set a 90% confidence level as minimum acceptance criteria in both areas.

Throughput of MANPGA PCNs were within the 90% confidence level factor. Comparison of average simulated flow time with historical flow time revealed that it was off by a substantial amount. After investigation, it was determined to add a buffer operation to PCNs 74126A, 74103A and 74010A to represent the process of inspecting all gyros to determine repair requirements and set them in



TYPICAL MANPG RCC ORGANIZATION CHART

FIGURE 10.1.1-3

a staging area until personnel are available to perform the work. The results are discussed in detail in section 6.0 of the DDB for MANPGA. The statistics then generated by the simulation model were within an acceptable range when compared to the As-Is condition. This simulation model database represents the As-Is condition for FY 88 and is a baseline for comparison purposes.

Brainstorming was performed during the model validation of RCC MANPGA. Representatives from production, scheduling, planning, quality and industrial engineering from WR-ALC and MDMSC participated in this session. Suggestions to reduce flow time and increase throughput were recommended and points noted. A "fishbone" (cause and effect) diagram was developed from these suggestions and is graphically depicted in section 9.0 of MANPGA's DDB.

Analysis of the model validation run output revealed that utilization of equipment is very low and manpower is high. Based on this analysis and the brainstorming session, the WR-ALC/MDMSC TI-ES team agreed to use the following assumptions and control factors to evaluate the effect on throughput.

- Workload for MANPGA will remain the same as FY 88.
- No change to manpower quantity.
- Following changes were made to certain equipment quantities to analyze their impact on throughput and was classified as Base, Base+ and Base++ (reference Table 10.1.2-1).

The L_9 Taguchi Array was constructed based on the above assumptions and factors and is depicted in Table 10.1.2-2. The table shows the overall throughput percentages for the PCNs that were profiled. The table also lists the individual PCNs which showed the best and worst throughput percentage under each experimental run.

The results produced by experimental runs show that the throughput of RCC MANPGA are all around 100% on all three conditions. The change in quantity of equipment, either reduction or increase, does not influence the average throughput of RCC MANPGA. This does confirm the assumption by WR-ALC/MDMSC of excessive equipment in RCC MANPGA.

MANPGA CONTROL FACTORS
TABLE 10.1.2-1

BASE			BASE+ (AS-IS)			BASE++		
EQUIP. NO.	EQUIPMENT NAME	EQUIP. QTY.	EQUIP. NO.	EQUIPMENT NAME	EQUIP. QTY.	EQUIP. NO.	EQUIPMENT NAME	EQUIP. QTY.
0450	CONSOLE	1	0450	CONSOLE	2	0450	CONSOLE	2
1112	CONSOLE	3	1112	CONSOLE	5	1112	CONSOLE	5
1473	MACH. LATHE	1	1473	MACH. LATHE	2	1473	MACH. LATHE	2
2020	RATE TABLE	1	2020	RATE TABLE	2	2020	RATE TABLE	2
2101	BRG RUN-IN	2	2101	BRG RUN-IN	3	2101	BRG RUN-IN	3
3559	TEST PANEL	2	3559	TEST PANEL	3	3559	TEST PANEL	3
3957	ROCK TABLE	2	3957	ROCK TABLE	3	3957	ROCK TABLE	3
9573	TEMP CHAMBER	2	9573	TEMP CHAMBER	4	9573	TEMP CHAMBER	4
0008	RUN-IN RACK	1	0008	RUN-IN RACK	1	0008	RUN-IN RACK	2
0527	FILL FIXTURE	1	0527	FILL FIXTURE	1	0527	FILL FIXTURE	2
6148	RUN-IN RACK	1	6148	RUN-IN RACK	1	6148	RUN-IN RACK	2

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MANPGA GYRO SHOP TAGUCHI ORTHOGONAL ARRAY

TABLE 10.1.2-2

RUN #	FACTORS & LEVELS						WORKLOAD (THROUGHPUT)		
	MANPOWER			OVERTIME		EQUIPMENT	INDUCTIONS: 3293: 130% OF FY 88		
	1	2	3	SAT	SUN		AVG.	BEST	WORST
1	ALL					BASE	100.0 %	74103A 103.0 %	74074A 95.0 %
2	ALL			YES		BASE +	99.9 %	74103A 103.0 %	74074A 92.0 %
3	ALL			YES	YES	BASE ++	100.8 %	74103A 103.0 %	74010A 99.5 %
4	50%	50%				BASE ++	100.3 %	74103A 102.6 %	74010A 99.2 %
5	50%	50%		YES	YES	BASE	100.6 %	74103A 102.6 %	74010A 99.6 %
6	50%	50%		YES		BASE +	100.6 %	74103A 102.6 %	74010A 99.9 %
7	1/3	1/3	1/3			BASE +	100.5 %	74103A 102.6 %	74010A 99.4 %
8	1/3	1/3	1/3	YES	YES	BASE ++	100.5 %	74103A 102.6 %	74010A 99.4 %
9	1/3	1/3	1/3	YES	YES	BASE	100.3 %	74103A 102.6 %	74010A 99.5 %
SURGE*	50%**		50%**			BASE	100.7 %	74103A 108.0 %	74126A 98.6 %

NOTES: * INDUCTIONS = 2865 (2 QTRS)
** TWO 12 HOUR SHIFTS.

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The throughput for the best and worst condition on all of the nine experimental runs was evaluated. PCN 74103A turned out to be the best due to the low requirements of direct labor, only 4.30 hours, and the high induction during first quarter. Analysis of PCNs listed under worst condition reveals that PCN 74074A has 33.00 hours of back shop dwell time and it does impact the throughput. All the other PCNs under this category do have throughput of well over 98%.

Analysis of experimentation results and engineering assessment during data collection reveals that RCC MANPGA could increase the utilization of equipment by a "common rotor repair cell" concept.

To evaluate the RCC MANPGA capability to respond to surge condition, the following assumptions were considered by WR-ALC/MDMSC team.

- Same manpower as in FY 88
- Reduced equipment as in Base condition
- Spread the manpower between two 12-hour shifts, five days a week
- Increase the FY 88 workload by 159%, which is the average surge factor provided by AFLC for weapon system serviced by WR-ALC Gyro shop

An experimentation run was executed with the above assumptions for two quarters. The average throughput shows that RCC MANPGA has the capability to meet surge condition even with the quantity of equipment reduced.

10.1.3 Description of Process Problems

The last few years have shown a reducing workload in the gyro shops. Model experimentation confirms equipment in general is very lightly loaded. Space is at a premium due mostly to moving the cable shop and some other mechanical and electrical workload in from other areas. The cleanliness of repair efforts moved in are not consistent with the cleanliness requirements demanded by gyro assembly. This has resulted in some quality degradation and throughput loss which MANPGA management could address through MDMSC's recommendation of facility reorganization.

The present method of repairing various gyros in all three MANPG units requires much duplication of equipment. Each product line requires run-in stations, balance machines, leak detectors, filling equipment, ovens, etc. The utilization time of the equipment is generally light. Rotor assemblies for the gyro assemblies require repair approximately 85% of the time and represent about 20% of the average hours to repair a gyro assembly.

Reducing the gyro rotor repair process flow time while improving manpower, equipment, material handling and floor space utilization is the subject of Focus Study No. 1.

10.1.4 Recommended Focus Study: Combine RCCs MANPGA, MANPGB and MANPGC at WR-ALC Gyro Rotor Assembly Repair to a Common Line Flow

The objective of this focus study is to provide a detailed analysis of all MANPG gyro rotor repair process technologies and propose efficient methods to improve flow time and resource utilization.

Table 10.1.4-1 details the areas that will be affected by this focus study. Also shown is the MDMSC assessment of the level of effort required in the focus study to evaluate individual areas of analysis.

10.1.4.1 Rationale Leading to Change

The present condition observed within the MANPG gyro RCCs indicated that equipment utilization in gyro rotor repair activities was generally light. Each RCC unit handled its gyro rotor workload according to individual line/technician availability. During the characterization of all three MANPG RCCs, it became evident that combining similar gyro rotor rebuild processes would create an efficient, flexible manufacturing operation resulting in significant savings. Table 10.1.4-2 expands upon the advantages/benefits of a cellular manufacturing environment.

GYRO ROTOR REPAIR "CELL" FOCUS STUDY NO. 1 CRITERIA CHECKLIST

TABLE 10.1.4-1 (SHEET 1 OF 2)

AREA OF ANALYSIS	ACTIVITY (WHAT & HOW)	LEVEL OF EFFORT		
		MIN	AVG	MAX
Process/Material Flow	Identify most efficient location/configuration of proposed process and the best means of integration into MANPG units repair process.			X
Equipment/Work Place Layout	Identify, in concert with process/material flow, the best location for housing the proposed system.			X
Facility Requirements	Review facility requirements & develop workable/cost effective design.			X
Labor Standards	Derive, by review of UDOS experimentation results, new labor standards and repair process flow times.		X	
Manpower	Identify RCC personnel skill level & training requirements.		X	
Task Assignments	Develop distributive assignment matrix & reassignment implementation plan.		X	
Material Requirements	Review and recommend material quantity, pricing and delivery schedule based on results of UDOS model experimentation results.		X	
Scrap Rates	Evaluate effective change on scrap rate data.	X		

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GYRO ROTOR REPAIR "CELL" FOCUS STUDY NO. 1 CRITERIA CHECKLIST

TABLE 10.1.4-1 (SHEET 2 OF 2)

AREA OF ANALYSIS	ACTIVITY (WHAT & HOW)	LEVEL OF EFFORT		
		MIN	AVG	MAX
Material Handling & Storage Methods	Define revisions to current methods as required by new cellular manufacturing environment.		X	
Inspection Techniques	Identify any changes in inspection procedures or levels of inspection required as a result of new process implementation.		X	
Equipment/Tools/Fixtures	Review requirements based on use of existing gyro rotor repair equipment, tools, and fixtures.			X
Process Delays	Identify and quantify positive effects of implementing recommended process.		X	
Part Identification	Review sequence of work and assertain impact and define any part control identification changes required for implementation of the recommended process.	X		
Quality	Develop base understanding of any changes in quality which would result from implementation of the new process.		X	
Personnel Safety	Identify safety concerns, both positive and negative, associated with *recommended technology.*		X	
Environmental Assessments	Identify environmental impact of recommended technology as they *relate to EPA requirements.*	X		

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CELLULAR MANUFACTURING ENVIRONMENT ADVANTAGES/BENEFITS

TABLE 10.1.4-2

CHARACTERISTICS	ADVANTAGES/BENEFITS				
	IMPROVED RESOURCE UTILIZATION	REDUCED COST	IMPROVED QUALITY	REDUCED FLOW TIMES	IMPROVED THROUGHPUT
MINIMIZE PRODUCT MOVEMENT	X			X	X
WORK-IN-PROCESS (WIP) MINIMIZED	X	X			X
PAC TRAINED WORKFORCE	X		X		
WORKLOAD SCHEDULE ADHERENCE	X	X		X	X
FOCUSED SUPERVISION	X	X	X	X	X
WORKLOAD CHANGE RESPONSIVENESS	X	X			

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The proposed assembly line repair techniques will improve efficiencies in manpower, equipment, material handling, and floor space utilization. Flow times will be reduced by improved production/process flexibility.

The following discussion develops the benefits of the recommended process technology and compares cellular manufacturing attributes with the current three individual gyro units process.

A cellular manufacturing environment created by combining all MANPG gyro rotor rebuild activities will accomplish significant cost benefits through process simplification. RCC MABPGA at AGMC's Displacement Gyroscope Repair Facility is currently organized with a dedicated gyro rotor (wheel) area.

The primary advantages of a repair "cell" methodology will be reduced flow times and improved product throughput resulting from enhanced coordination of MANPG gyro rotor repair operations.

It is envisioned that the MANPGA RCC will become the primary gyro rotor rebuild facility when a cellular manufacturing system is provided. Therefore, MANPG section labor savings will be realized.

Modification of the facility will be required to incorporate the gyro rotor rebuild cell elements. MDMSC suggests that new equipment and tooling requirements can be minimized through effective WR-ALC/MDMSC team planning and utilization of existing major process equipment. For example, a single Dynamic Gyro Rotor Laser Balancing System fixtured for one common rebuild cell would eliminate the duplication of this $250,000 processing machinery in the two additional MANPG RCCs. Enhanced material handling equipment may also be of benefit and recommended upon final focus study analysis results.

The detailed focus study analysis will provide estimated productivity improvements quantifying expected reductions in material usage rates and rotor repair inspection time. A single bearing refurbishment facility would reduce scrap rates and yield an estimated improvement in material usage by 20%.

Personnel safety and environmental concerns will be noted during the subject focus study analysis. The amount of cleaning solvents used will be reduced by combining the three operations at one location.

The incorporation of a cellular manufacturing environment encompassing all MANPG gyro rotor rebuild activities will open other areas of investigation for enhancing other repair processes. Improvements gained through reduced labor costs and efficient equipment utilization will allow additional/new workload to be inducted into MANPG.

10.1.4.2 Potential Cost Benefits

An annual cost savings of $447,873 occurs from the implementation of the recommended improvements as shown in Table 10.1.4-3. This represents savings from a 20% reduction in gyro rotor rebuild process flow times through increased labor efficiencies resulting from a reorganized, well-trained rotor repair team with enhanced material handling techniques and the elimination of two planned gyro rotor laser balancers.

Additional potential cost savings resulting from reduced floor space requirements, batch processing methodologies and improved first time quality through a team of well trained rotor repair experts cannot be quantified until the focus study is completed.

Intangible benefits from the following improvements should also be considered.

- Reduced worker exposure to harsh cleaning chemicals, and associated fumes
- Clean, efficient work stations
- Egronomically designed fixtures and tools

The investment cost of the recommendations is estimated at $25,000. This cost includes the focus study effort and the implementation cost resulting from a cellular manufacturing rotor repair system and egronomically designed flexible fixturing and assumes cost avoidance resulting from the elimination of two planned gyro rotor laser balancers.

SUMMARY OF INVESTMENT COST AND ANNUAL SAVINGS (CONSTANT FY89 DOLLARS)

TABLE 10.1.4-3 (SHEET 1 OF 2)

	CURRENT ANNUAL COSTS	PROPOSED CHANGE	
		INVESTMENT COSTS	ANNUAL COSTS
NONRECURRING COSTS (1)			
FOCUS STUDY	$0	$260,000 (2)	$0
FACILITIES			
LAND	$0	$0	$0
BUILDINGS	$0	$250,000 (3)	$0
SUPPORT EQUIPMENT			
DEVELOPMENT	$0	$0	$0
ACQUISITION	$0	($450,000) (4)	$0
INSTALL & CHECKOUT	$0	($45,000) (5)	$0
LOGISTICS SUPPORT			
INITIAL SPARES	$0	$0	$0
INITIAL TRAINING (DEV & PRESENTATION)	$0	$10,000 (6)	$0
TECHNICAL DATA	$0	$0	$0
TOTAL NONRECURRING COST	$0	$25,000	$0
RECURRING COSTS (1)			
TOUCH LABOR	$2,239,365 (7)	$0	$1,791,492 (8)
SUPPORT EQUIP MAINT	$0	$0	$0
SPARES AND SPARES MGMT	$0	$0	$0
TECHNICAL DATA	$0	$0	$0
MOD KITS	$0	$0	$0
CONFIGURATION DATA MGMT	$0	$0	$0
UTILITIES	$0	$0	$0
TOTAL RECURRING COSTS	$2,239,365	$0	$1,791,492
TOTAL COSTS	$2,239,365	$25,000	$1,791,492
ANNUAL COST SAVINGS	$447,873		

NUMBER OF MONTHS FOR FOCUS STUDY	4.5
NUMBER OF MONTHS TO IMPLEMENT CHANGES	12

SUMMARY OF INVESTMENT COST AND ANNUAL SAVINGS (CONSTANT FY89 DOLLARS)
TABLE 10.1.4-3 (SHEET 2 OF 2)

NOTES:

(1) ONLY ITEMS THAT ARE SIGNIFICANTLY AFFECTED BY THE PROPOSED CHANGE HAVE BEEN ESTIMATED

(2) ENGINEERING ESTIMATE FOR USE IN ENGINEERING TRADE STUDIES ONLY, DOES NOT REPRESENT FIRM PRICING

(3) ROM ESTIMATE OF IMPLEMENTATION COSTS FOR GYRO ROTOR CELL FACILITIES REARRANGEMENT INCLUDING NEW ERGONOMICALLY DESIGNED FLEXIBLE FIXTURING.

(4) $ 500,000 NEGATIVE COST INVESTMENT (COST AVOIDANCE) DUE TO ELIMINATION OF TWO PLANNED GYRO ROTOR LASER BALANCERS. ADDITIONAL NEW TOOLING ESTIMATED AT $50,000.

(5) ESTIMATED AT 10% OF SUPPORT EQUIPMENT ACQUISITION COST.

(6) TRAINING OF REORGANIZED GYRO ROTOR REPAIR TEAM.

(7) BASED ON INTERVIEW ESTIMATES THAT GYRO ROTOR REPAIR EFFORT EQUALS 20% OF TOTAL GYRO REPAIR ACTIVITIES IN RCCs MANPGA, MANPGB AND MANPGC.

0.2 x (TOTAL YEARLY OPERATING COSTS - INDIRECT MATERIAL COSTS)

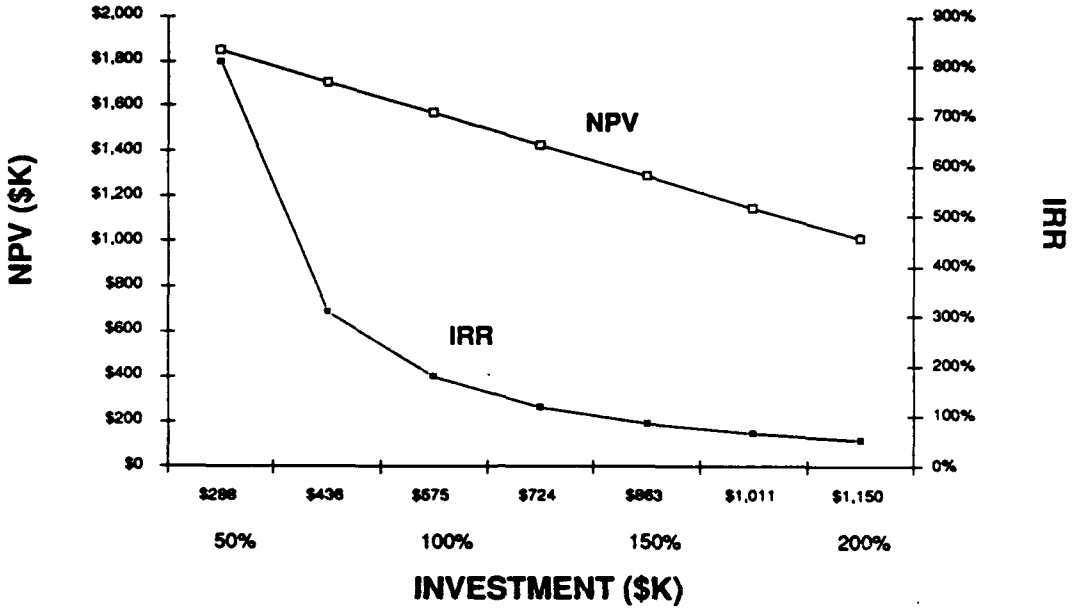
0.2 x ($5,634,740 + $4,206,636 + $5,478,706 - $1,636,264 - $832,123 - $1,654,871)

(8) IMPROVEMENT OF 20% OF EFFORT TO REPAIR GYRO ROTOR ASSEMBLIES.

0.8 X [CURRENT ANNUAL COSTS]

0.8 X [0.2 ($5,634,740 + $4,206,636 + $5,478,706 - $1,636,264 - $832,123 - $1,654,871)]

A sensitivity analysis was performed in which the additional investment cost (total investment cost minus cost associated with the elimination of the two planned gyro rotor laser balancers) varied between 50% and 200% of the estimated costs (see Figure 10.1.4-2).



CBA SENSITIVITY ANALYSIS
FIGURE 10.1.4-2

10.1.4.3 Risk Assessment of Achieving Study Goals

The following is a list of the possible risks in achieving the study goals. MDMSC believes these risks are minimal.

- Actual cost savings can be quantified only after the detailed focus study is completed and the optimum improvement recommendations selected for implementation.
- Interviews indicated current WR-ALC gyro workload projections are decreasing but exact future planned workload schedules are unknown.
- Implementation costs based on facility rearrangements are unquantifiable without performing the actual focus study.
- Some inventory stockpiling may be required prior to production interruption during the proposed process technology improvement insertion.

10.1.4.4 Duration and Level of Effort

A thorough review of all MANPG gyro rotor rebuild activities will determine the cost effective modernization improvements possible at WR-ALC.

MDMSC recommends a four and one-half month long focus study period of performance to:

- Meet with WR-ALC personnel to coordinate activities.
- Survey Honeywell Corporation's computer-integrated manufacturing facility where precision gyros are assembled.
- Evaluate new capital equipment needs and obtain quotes from vendors.
- Summarize all cost-effective productivity improvement opportunities.
- Prepare descriptive facility layouts of proposed work stations.

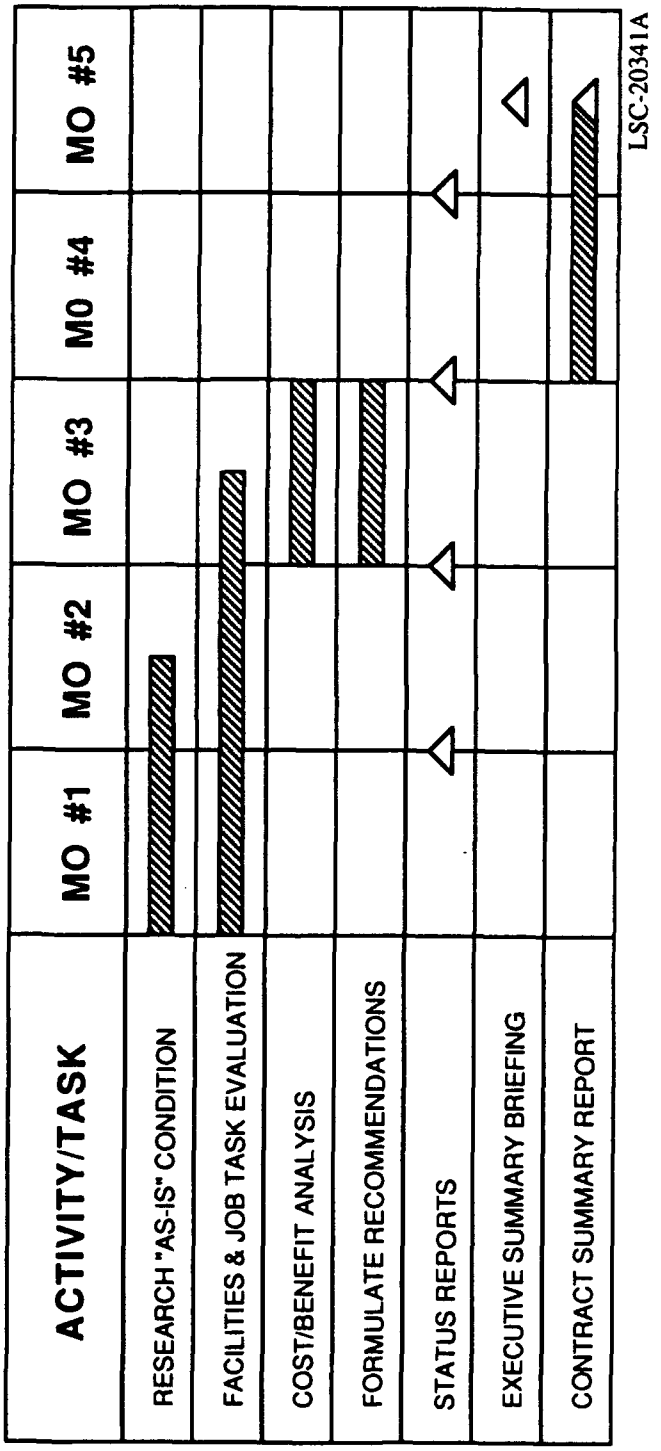
Figure 10.1.4-3 illustrates the proposed schedule to accomplish FSR No. 1.

It is estimated that a total of $260,000 is required to implement this recommendation. This number is an engineering Rough Order of Magnitude (ROM) estimate for engineering trade studies only; it does not represent firm pricing.

10.1.5 Other Observations

The other observations described in this section were not considered as focus studies or quick fixes because they had a less significant impact on the areas of time, quality, or cost. These observations are recorded to assist WR-ALC in developing ideas that will further enhance their operations.

The observations which follow were originally identified as Quick Fix and Focus Study improvement opportunities and are detailed as such in the MANPGA Database Documentation Book. After review by the MDMSC/WR-ALC TI-ES team, it was mutually agreed that they should be presented as other observations for future reference.



PROPOSED FSR NO. 1 SCHEDULE

FIGURE 10.1.4-3

Management Improvement Opportunities

- Evaluate Obsolescence of Old Bench Test Sets
  - Current Condition: It was observed that many of the line or bench test sets are difficult to support because of obsolescence. Surge conditions could experience problems from this condition and possibly from a lack of trained gyro technicians due to disappearing workload and natural attrition.

    In particular, rate gyro fill station no. 231E427G1 has been very difficult to maintain because of age and design. The stand has been responsible for downward negotiation of inducted workload.
  - MDMSC Recommendation: Address this improvement opportunity by defining a single station approach similar to private industry to simplify the rate gyro fill procedure and allow versatility in gyro models processed.

    A QP4 action team should also conduct a study to identify, plan and execute corrective actions prior to lengthy production interruptions due to other unsupportable test equipment. Such a plan must be completed to assure wartime/readiness and/or an acceptable surge posture.
- Reduce Test Time/Improve Test Accuracy For PCN 7401 Vertical Gyro Operations 20 and 200.
  - Current Condition: Both operation 20 and 200 are performed in the same manner. The gyroscope is tested on the automatic test stand, #70524, Contraves Vertical Console. If the unit fails for drift in accuracy, the unit is routed to the manual panel, L.T. 3330, gyro test set. The test is re-run and the unit accepted if drift accuracy meets specification requirements. Present methods require retest of approximately 50% of the gyros. It does not assure improved accuracy of product being returned to the field.

Actual interviews with test personnel revealed the double test procedure. Further discussion exposed the reasoning behind the procedure. The computer program in the Contraves vertical console improperly calculates earth rate drift in one or more headings. When the unit under test fails drift rates, it is assumed that the program error is the reason for the failure and therefore the failure is not valid and re-run is justified. This is valid; however earth rate correction is a fixed rate at a heading and latitude, therefore an incorrect value is applicable to both passing and failing units. To re-run only failures does not assure shipping an acceptable product.

- MDMSC Recommendation: Route all products to manual panel, LT 3330 gyro test set for operations 20 and 200. Accept or reject by test results obtained. Correct test program for automatic test stand, #705024 Contraves vertical test console, before testing any product across it.

• Analyze Cost Effectiveness of Implementing a Dynamic Gyro Rotor Laser Balancing System for WR-ALC Similar to AGMC

- Current Condition: During site interviews, it was noted that a Productivity, Reliability, Availability and Maintainability (PRAM) program funded, dynamic gyro rotor laser is scheduled to be installed in the last quarter of 1989 in the AGMC displacement gyroscope wheel repair facility. WR-ALC/MANPG is also planning the implementation of laser balancing their specific gyro rotors.
- MDMSC Recommendation: MANPG at WR-ALC should delay current procurement action on a costly (approximately $250K) Gyro Rotor Laser Balancing System until the AGMC displacement gyro shop has analyzed the true implementation costs and efficiencies involved. In particular, initial concerns expressed involve product surface roughness quality and possible processed material particulate contamination. A time interval between similar projects should be allowed for comparison purposes for the efficient planning, implementation and insertion of high technology such as the subject second laser balancing system.

A potential improvement opportunity would involve a focal point at WR-ALC to coordinate and expedite the transfer of the high technology laser balancing system knowledge to MANPG/WR-ALC to maximize overall AFLC/MA efficiency.

Operational Improvement Opportunities

- Improve Instrument Bearings Procurement and Handling Procedures
  - Current Condition: Instrument bearings quality related problems impact costs and schedule within MANPG's gyroscope repair activities. Corrosion is frequently evident on packaged bearings when initially received at the MANPG facility. Significant rework/repair costs occur associated with bearing reinspection, scrap efforts and nearly 100% cleaning for salvage.
  - MDMSC Recommendation: AFLC/WR-ALC initiate tighter quality control procedures during receiving inspection operations. Zero defect components from suppliers will reduce repair/assembly labor costs, increase throughput and reduce flow times in WR-ALC gyro repair operations. Also, the methodology of improving supplier reliability could be transferred across the command, avoiding any similar rework costs at AGMC or other bearing users.

Process Capability Opportunities

- Reclaim PCN 74126A Spin Axis Bearings
  - Current Condition: The races of the spin axis bearings of the 74126A gyro rotors are pressed out and scrapped along with the ball complement and outer races. The present operation does not consider re-use of either bearing or bearing races. The races are placed in large boxes which tends to further damage parts.

    Observation of wheel teardown showed races being removed that appeared to show little or no wear. Some of the bearings still contained lubrication with no discoloration. Bearings and races were examined under high magnification and no wear was evident.

The bearings and races are replaced in matched pairs. Examination of the unit does not immediately reveal the reasoning for matching race to bearing. This must be reviewed, but whichever is required, a process for reusing the bearing could be applied.

- MDMSC Recommendation: A QP4 action team should conduct a study to determine if matching is necessary. If so, remove the bearing while maintaining match set control. Package the removed sets to prevent damage. Replace bearings and rebuild wheel as per present process. Gather bearings for cleaning, reclamation and re-verification.

  If matching is not necessary, use the above mentioned procedure but reclaim bearings and races separately.

Technology Improvement Opportunities

- Reduce PCN 74126A Flow Time Through Fixture Improvement
  - Current Condition: The directional gyroscope is placed into the Operation 100 calibration stand and then the technician sits down on a very low stool to observe the azimuth scale reading through a straight line borescope. The technician must stand up again to adjust the leveling axis as required and then sit down once more to verify setting. This setup is repeated as necessary to continue calibration.

    The repetitive sitting and standing motions produce both operator fatigue and unsafe conditions. The stool is required to be-low due to eye alignment and the physical hazards to the operator are increased by casters. The casters are also required to improve the sighting operation.
  - MDMSC Recommendation: Place directional gyroscope into the calibration stand. Observe the azimuth scale through an "angled" borescope established at standing eye level. Adjust leveling axis, verify setting, and continue calibration.

- Motorize Dividing Head Stands
  - Current Condition: The manual test stands for directional and vertical displacement gyros are positioned and/or turned through cranking of hand wheels or hand wheel extenders. The hand cranking is laborious and is avoided by the operator using alternate equipment and/or developing methods outside the Technical Order.
    Directional gyros were observed waiting the availability of an alternate test set that was motor driven in one axis. Actual interviews of RCC personnel determined this was preferred to hand cranking the manual dividing heads. A smooth rate was difficult to maintain by the hand cranking method.
  - MDMSC Recommendation: MDMSC recommends the dividing heads of the manual test stands be motorized in both axes. The motor drives should be frictional to eliminate the need for expensive clutching systems and should allow for final positioning by the operator to eliminate encoders and servo systems. The drives should allow for a smooth constant rate but need not be of great accuracy.

    The benefit to be gained is test station capacity and versatility. By removal of the test stand avoidance situation adherence to the Technical Orders will improve. Some cost savings are to be realized by reducing operator fatigue but would be difficult to quantify.

10.2 MANPGB ANALYSIS AND FOCUS STUDY RECOMMENDATIONS

The MANPGB RCC, along with its sister Gyro Section RCCs MANPGA and MANPGC, are responsible for the overhaul and test of various miniature rate, vertical, two axis displacement gyros and flight data instruments. The workload within MANPGB consists of MISTR and exchangeables.

The MDMSC team has developed a good working relationship with the Gyro Unit No. 2 repair operations personnel. Gyro personnel were instrumental in the success of the site survey tasks such as data collection, operation profiles, shop floor interviews and review of facility layouts. This provides the basis to characterize the operation of MANPGB and allows for the identification of process improvement opportunities. MDMSC appreciates the excellent cooperation received from the entire WR-ALC team.

During initial characterization of the MANPGB RCC, a total of 11 potential improvement opportunities were identified (reference MANPGB Database Documentation Book, Potential Improvement Opportunities section). After review of this original set of opportunities by the MDMSC/WR-ALC team, six improvement opportunities were selected to be pursued as the focus of the TI-ES Program activities relating to MANPGB.

The first improvement opportunity, a focus study, titled Combine RCCs MANPGA, MANPGB and MANPGC Gyro Rotor Assembly Repair to a Common Line Flow, recommends inserting a Just-In-Time (JIT) cellular manufacturing environment to improve coordination of MANPG gyro rotor repair activities and substantially reduce flow times and resource requirements. Production/process flexibility and quality will improve a measurable amount as well. This focus study is identified in paragraph 10.2.4 and was previously presented in detail in paragraphs 10.1.4 through 10.1.4.4.

The proposed focus study investigation will allow for a detailed summary of the expected cost savings/benefits to MANPGB repair/remanufacturing operations. Upon completion of the focus study, the As-Is baseline information will be used

to define discrete quantitative as well as qualitative changes that can be made to improve the following:

- Resource Utilization
- Cost
- Quality
- Product Throughput
- Process Flow Time

Five of the improvement opportunities were selected to be presented as quick fixes and are summarized below:

- Improve Gimbal/Spin Bearing Handling in MANPGA, MANPGB and MANPGC
  Proposes establishing better material handling techniques to increase the yield of bearing refurbishment operations.

- Improve Fixturing the Induction Machines in MANPGA, MANPGB and MANPGC
  Proposes how safety and product quality improvements can be derived from a consistent fixturing methodology for gyro desoldering activities.

- Re-evaluate Need for Diagnostic Checks at All MANPG RCCs
  Proposes that based on historical E046B data, when wheel repair occurrence factors of 90% and greater are noted, a cost benefit can be derived by eliminating the limited value diagnostic testing for certain gyroscopes.

- Improve Bonding of PCN 20012A Tapes in MANPGB
  Proposes that the acquisition of a thermo-compression bonder could allow rebonding of separated, undamaged tape which is currently scrapped.

- Relocate Mass Spectrometers in MANPGB
  Should eliminate nonproductive transit times away from the gyro seal repair area. Current concerns of potential air contamination by the mass spectrometers could be solved by improved ventilation and/or duct work if necessary.

These quick fix opportunities offer significant benefits to MANPGB in terms of quality, time and cost and are described in detail under separate cover, reference Technology Insertion-Engineering Services Process Characterization, Task Order No. 1, Volume VII Quick Fix Plan WR-ALC, MANPGB Quick Fix opportunities section.

The remainder of the original MANPGB improvement opportunities are presented as other observations and are described in paragraph 10.2.5 of this document.

10.2.1 Description of Current Operations

MANPGB is a Resource Control Center (RCC) under the MANPG section of the Industrial Products Division (MAN) at WR-ALC. MANPGB is located in Building 158 in the center portion of the building. The area is maintained as a Class 300,000 clean room though the common air locks, work restrictions, and clean room garb is not required. Observations in the area here established that the MANPGB cleanliness level exceeds both MANPGA and MANPGC.

The workload is primarily MISTR work. It consists of various vertical, two axis displacement gyro repair and flight data instruments. The area also has responsibility for operation of the automatic gyroscope test stations and support computer systems that service all three RCCs (MANPGA, MANPGB, and MANPGC). Table 10.2.1-1 depicts the PCNs involved in the FY 88 80/20 workload analysis. Most gyros in the area are of 1955 to 1970 design. Because of this ageing product mix, the workload has been decreasing for some time. Induction and repair process is compatible to private industry. Figure 10.2.1-1 is a general process flow chart of gyro repair operations most common within RCC MANPGB.

MANPGB GYRO SHOP FY 88 WORKLOAD
TABLE 10.2.1-1

REPRESENTATIVE GYRO FAMILY PCN	FY 88 INDUCTIONS				TOTALS
	1ST QTR	2ND QTR	3RD QTR	4TH QTR	
74051A	975	966	921	927	3789
20012A	333	322	330	314	1299

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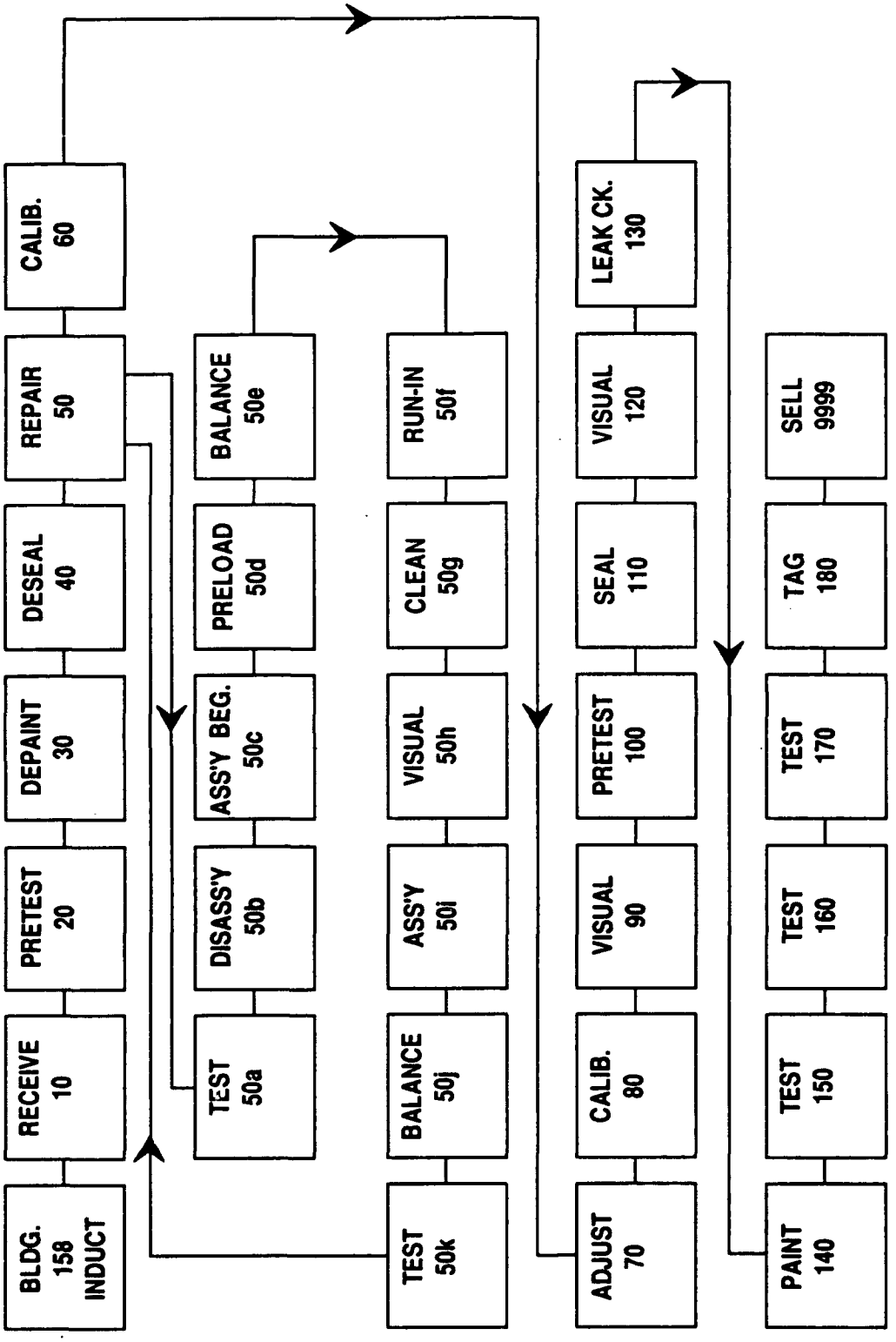
MANPGB equipment consists of individual workbench stations, and a small machine shop support area. Support processes in this RCC include depainting and unsealing, filling, painting, and automatic testing. The area also contains many manual test stands and two axis manual tables. The automatic stands consist of computer and switching panels with large three axis or single axis rate stands. The tooling is standard precision hand tools furnished to the operators in complete kit se plus some amount of special tooling for each model, but little is complex enough to require much concern. The test sets, except for the Automatic Test Equipment (ATE) and contractor manual test stands are of a design age consistent with the product design. It is doubtful that the test sets can be properly supported much longer. The Contraves test stations are of a more recent design and are closer to state of the art. They are manually programmable and capable of testing a large variety of gyroscopes.

The repair process technologies within MANPGB consist of defining the gyroscope malfunction causes, repairing as required, and retesting to verify the completeness of the repair. The gyros are pretested to identify malfunctions, torn down and repaired as required to technical overhaul manuals. Repair is



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MANPGB DISPLACEMENT GYRO PROCESS FLOW CHART
FIGURE 10.2.1-1

generally accomplished through replacement of worn and/or defective piece parts. The rebuild and acceptance testing is also directed by Technical Orders and test specifications. Some mandatory replacement of high failure items are directed by Technical Orders to extend MTBF. Precision bearing and miniature slip rings/brushes are examples of some 100% replacement parts.

The first step in the gyro repair process is the manual desoldering of the sealed gyro case (cover) to allow removal of the gyro for repair. Shop floor interviews and observations indicate a quick fix opportunity exists to provide proper fixturing during gyro covers unsealing operations utilizing the induction heater machine. This opportunity, titled Improve Fixturing the Induction Machines at All MANPG RCCs, is presented in detail in paragraph 10.1.4 of the MANPGA QFP.

The metallic gyro cover halves must then be thoroughly depainted by plastic bead blasting and cleaned. Cost efficiencies and improved throughput could be achieved if certain operations were performed in cost-effective lot quantities with egronomically designed tools and fixtures (addressed in Focus Study No. 1 of AGMC CSR Volume II). This Focus Study Recommendation (FSR) will also define opportunities for enhanced GRU unseal, depaint, seal and leak check product quality through the utilization of an improved soldering/sealing system. MDMSC recommends that WR-ALC participate with AGMC in the conduct of the FSR to allow realization of consistent technology insertion of potential improvements at both AFLC sites.

Another quick fix opportunity was identified due to the nonproductive transit times necessary to utilize the mass spectrometers for leak checking gyros. This opportunity, Relocate Mass Spectrometers in MANPGB is addressed in detail and presented in paragraph 10.2.2 in the MANPGB QFP.

In depot repair of gyroscopes, most of the time is spent in testing. Units are diagnostically tested, faulty components replaced and functionally tested. Repair is usually performed by a single technician at a bench-type laminar flow booth work station. Bench repair does not require complex routings and is dedicated to a particular product.

A quick fix opportunity to improve manpower utilization and throughput was observed on PCN 74146A gyro diagnostic testing procedures and is addressed in detail in paragraph 10.1.5 of the MANPGA QFP.

MANPGB is responsible for the functional testing of the entire gyro workload from all three MANPG RCCs across twenty-six Automatic Test Equipment (ATE) units and numerous manual test stations in various locations in each of the RCCs. The preferred method of test operations at RCCs MANPGB/WR-ALC and MAPBGA/AGMC is to route all incoming diagnostic and final acceptance gyro testing across the Contraves Automated Test Stations. The intent is to reduce labor input by performing testing on multiple gyroscopes in test stations with minimum test personnel and to gain maximum product reliability by improving personnel confidence in test results.

Gyros are currently tested on ATE or manual test stands. Unit performance levels are printed out with product specification limits and accept/reject decisions. This same information is recorded and stored on computer hard disks. This methodology is currently unusable because the ATE is down approximately 50% of the time due to malfunctions and/or lack of confidence of the test values obtained.

Both MANPGB/WR-ALC and MAPBGA/AGMC maintain monthly records of the ATE availability. AGMC has initiated a formal reporting system referred to as Station Availability Maintenance Program (SAMP). WR-ALC has an informal report developed by the ATE area supervisor for his own use. Although different in format and completeness, each reporting system shows uptime/downtime of gyro test stations.

A focus study has been recommended at MAPBGA/AGMC (Focus Study No. 2 of AGMC CSR Volume II) to provide a detailed analysis of the maintenance problems associated with this ATE and proposes efficient methods to improve the utilization of the automated test stations. Increased ATE availability would permit maximum testing of gyroscopes; therefore accomplishing near term productivity gains, improving wartime readiness and surge posture, as well as

improving schedule flexibility. MDMSC recommends that WR-ALC participate with AGMC in the conduct of the FSR to allow realization of consistent technology insertion at both AFLC sites.

After repair and calibration, resealing of the gyro covers is again accomplished by a manual soldering process. The next major process involves the technician pressurizing the gyro with a gas, immersing it into a liquid and performing a gross leak check by a bubble test. If a leak is detected, the unit must be resealed additionally in the area of the visible leaks. After subsequent recycles and successful completion by the gross leak bubble test, the gyro seal integrity is final functional tested on a Veeco vacuum leak detection system.

In parallel with gyro repair activities, all wheel (gyro rotor) repair process technologies are routinely batch processed in quantities of 10 to 20 units. Figure 10.1.1-2 (previously referenced) is a general process flow chart of MANPG wheel repair operations. During process characterization efforts in all three MANPG RCCs it was noted that each unit is responsible for several gyro rotor PCNs and perform the necessary workload's repair process technologies according to individual line and/or technician availability. Focus Study No. 1, will address this problem by determining the feasibility of combining RCCs MANPGA, MANPGB and MANPGC Gyro Rotor Assembly Repair to a Common Line Flow. Improved coordination of MANPG gyro rotor repair activities will substantially reduce flow times and resource requirements. This focus study is presented in detail in paragraphs 10.1.4 through 10.1.4.4.

Material handling in MANPGB is mostly accomplished by the repair operator hand carrying the items between stations. The gyroscopes are small, weighing from ounces to a few pounds. Units are repaired by a single mechanic rather than by line flow process. The one exception to this method is rotor repair, which are repaired in groups rather than one at a time. The repair is still accomplished by a mechanic, not a line, but an operation is completed on multi assemblies before moving to the next operation.

A quick fix opportunity, involving wheel repair operations, is titled Improve Gimbal/Spin Bearing Handling. MDMSC observed that establishing improved material handling techniques would increase the yield of bearing refurbishment operations. This quick fix is presented in detail in paragraph 10.1.3 of the MANPGA QFP.

Storage is on line in MANPGB. It is accomplished on shelved hand trucks between aisles on the repair floor. The items for repair are received, logged in, and placed on the storage trucks for pretest. After pretest, the items are returned to the truck to wait the availability of a mechanic. The item is repaired and calibrated then returned to the truck or another truck for test and ship.

The facility layout drawing of the MANPGB sections of Building 158 does represent the As-Is condition of the facility at the time of the study. The area includes workbench areas, ATE areas, depaint, unsealing, resealing, and paint area. The area appears to be the most stable of Building 158.

MANPGB has a stable work force with little variance. The work force is comprised of instrument mechanics, three supervisors, a clerk and a senior supervisor. The following is a breakdown of the mechanics within MANPGB.

Skill Code	Skill Level	Quantity	Experience
WG 3359	G-10	13	19.3 yrs.
WG 3359	G-09	36	17.1 yrs.
WG 3359	G-07	8	6.4 yrs.
WG 7009	G-04	1	10.0 yrs.

It is to be noted that the work force is shared between the gyro RCCs as workloads vary. A major concern is availability of trained instrument mechanics if increased workload was demanded. The age of the work force should also be of a concern. Experience is very high but natural attrition is reducing the numbers faster than training is furnishing younger mechanics. Surge conditions would be impacted by this constraint.

10.2.2 Statistical System Performance Measures

MANPGB repairs and tests various vertical, two axis miniature rate displacement gyros and flight data instruments. The WR-ALC/MDMSC TI-ES team selected PCNs 74051A and 20012A to represent a generic family of gyros commonly overhauled in this RCC. The team's process characterization of these gyros included gathering data via:

- Interviews with ALC/RCC personnel
- WCD historical information with scheduling personnel assistance
- Maintenance and production interviews concerning equipment MTBF and MTTR

This profile data sheet information was then transferred to personal computer files using a Lotus 1-2-3 database storage system. After data verification, flat files for this RCC were generated. Simulation runs were then executed utilizing UDOS 2.0.

The WR-ALC/MDMSC TI-ES team, along with an AFLC representative performed a statistical comparison of the UDOS 2.0 model simulation outputs for the FY 88 MANPGB repair process. The validation was performed by comparing average simulated flow times to historical flow times and average simulated throughput to FY 88 throughput. The WR-ALC/MDMSC team set a 90% confidence level as minimum acceptance criteria in both areas.

Comparison of average simulated flow time with historical flow time revealed that it was 54% higher than historical flow times. After investigation, it was determined that the difference was due to the queuing on resources IG09 and manpower. The results are discussed in detail in section 6.0 of the DDB for MANPGB. The statistics then generated by the simulation model were within an acceptable range when compared to the As-Is condition. This simulation model database represents the As-Is condition for FY 88 and is a baseline for comparison purposes.

Brainstorming was performed during the model validation of RCC MANPGB. Representatives from production, scheduling, planning, quality and industrial engineering from WR-ALC and MDMSC participated in this session. Suggestions to reduce flow time and increase throughput were discussed and points noted. A "fishbone" (cause and effect) diagram was developed from these suggestions and is graphically depicted in section 9.0 of MANPGB's DDB.

Analysis of the model validation run output revealed that utilization of equipment is very low and manpower is high. Based on this analysis and the brainstorming session, the WR-ALC/MDMSC TI-ES team agreed to use the following assumptions and control factors to evaluate the effect on throughput:

- Workload for MANPGB will remain the same as FY 88.
- No change to manpower quantity.
- Changes were made to certain equipment quantities to analyze their impact on throughput and was classified a Base, Base+ and Base++, reference Table 10.2.2-1.

The L_9 Taguchi array was constructed based on the above assumptions and factors and is depicted in Table 10.2.2-2. The table shows the overall throughput percentages for the PCNs that were profiled. The table also lists the individual PCNs which showed the best and worst throughput percentage under each experimental run.

The results produced by experimental runs show that the throughput of RCC MANPGB average around 99% on all three conditions. The change in quantity of equipment, either reduction or increase, does not influence the average throughput of RCC MANPGB. This does confirm the assumption by WR-ALC/MDMSC of excessive equipment in RCC MANPGB.

The throughput for the best and worst condition on all the nine experimental runs was evaluated. Because only two PCNs are characterized in this RCC, the best and worst PCN did not make much sense. Moreover, the UDOS 2.0 model indicates that changes in throughput of less than 5% are not significant for PCNs with induction rates of more than 20 per year.

MANPGB CONTROL FACTORS
TABLE 10.2.2-1

BASE			BASE+ (AS-IS)			BASE++		
EQUIP. NO.	EQUIPMENT NAME	EQUIP. QTY.	EQUIP. NO.	EQUIPMENT NAME	EQUIP. QTY.	EQUIP. NO.	EQUIPMENT NAME	EQUIP. QTY.
3346	LEAK DETECTOR	5	3346	LEAK DETECTOR	10	3346	LEAK DETECTOR	5
5139	BALANCE	1	5139	BALANCE	3	5139	BALANCE	1
9548	CONSOLE	6	9548	CONSOLE	9	9548	CONSOLE	6
			2314	FILL STAND	1*	2314	FILL STAND	6**

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NOTES: * BATCH: MIN-1/MAX-25
* BATCH: MIN-1/MAX-6

MANPGB GYRO SHOP TAGUCHI ORTHOGONAL ARRAY

TABLE 10.2.2-2

RUN #	FACTORS & LEVELS						WORKLOAD (THROUGHPUT)		
	MANPOWER			OVERTIME		EQUIPMENT	INDUCTIONS: 5048: 130% OF FY 88		
	1	2	3	SAT	SUN		AVG.	BEST	WORST
1	ALL					BASE	99.3 %	20012A 99.6 %	74051A 99.0 %
2	ALL			YES		BASE +	99.9 %	74051A 99.9 %	20012A 99.8 %
3	ALL			YES	YES	BASE ++	99.8 %	74051A 99.9 %	20012A 99.7 %
4	50%	50%				BASE ++	99.6 %	20012A 99.6 %	74051A 99.5 %
5	50%	50%				BASE	98.5 %	20012A 99.9 %	74051A 98.0 %
6	50%	50%		YES		BASE +	99.9 %	74051A 100.0 %	20012A 99.7 %
7	1/3	1/3	1/3	YES		BASE +	100.4 %	74051A 100.6 %	20012A 99.8 %
8	1/3	1/3	1/3	YES	YES	BASE ++	100.2 %	74051A 100.2 %	20012A 100.0 %
9	1/3	1/3	1/3	YES	YES	BASE	100.3 %	74051A 100.5 %	20012A 99.8 %
SURGE*	50%**	50%**				BASE	98.3 %	20012A 99.5 %	74051A 98.0 %

NOTES: * INDUCTIONS = 4168 (2 QTRS)
** TWO 12 HOUR SHIFTS.

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Taking the statistical fluctuations and the sporadic induction, it indicates that both PCNs 74051A and 20012A have capability to meet the requirement.

Analysis of experimentation results and engineering assessment during data collection reveal that RCC MANPGB could increase the utilization of equipment by a "common rotor repair cell" concept.

To evaluate the RCC MANPGB's capability to respond to surge condition, the following assumptions were considered by WR-ALC/MDMSC team:

- Same manpower as in FY 88
- Reduced equipment as in Base condition
- Spread the manpower between two 12 hour shifts - five days a week
- Increase the FY 88 workload by 159%, which is the average of surge factor provided by AFLC for weapon systems serviced by the WR-ALC Gyro shop.

An experimentation run was executed with above assumptions for two quarters. The average throughput, which is about 98%, shows that RCC MANPGB has capability to meet surge condition even with reduce quantity of equipment.

10.2.3 Description of Process Problems

The intent of this paragraph is to expound on major process problems for which there are focus study recommendations. The focus study, Combining Gyro Rotor Assembly Repair to a Common Line Flow, is designed to improve performance within the MANPG Gyro RCCs and is presented in detail in this document in MANPGA paragraph 10.1.4.

10.2.4 Recommended Focus Study: Combine RCCs MANPGA, MANPGB and MANPGC at WR-ALC Gyro Rotor Assembly Repair to a Common Line Flow

Refer to paragraphs 10.1.4 through 10.1.4.4.

10.2.5 Other Observations

The other observations described in this section were not considered as focus studies or quick fixes because they had a less significant impact on the areas of time, quality, or cost. These observations are recorded to assist WR-ALC in developing ideas that will further enhance their operations.

The observations which follow were originally identified as Quick Fix and Focus Study improvement opportunities and are detailed as such in the MANPGB DDB. After review by the MDMSC/WR-ALC TI-ES team, it was mutually agreed that all other opportunities should be recorded as observations and presented in this document for future reference.

Management Improvement Opportunities

- Evaluate Obsolescence of Old Bench Test Sets
  - Current Condition: It was observed that many of the line or bench test sets are difficult to support because of obsolescence. Surge conditions could experience problems from this condition and possibly from a lack of trained gyro technicians due to disappearing workload and natural attrition.
  - MDMSC Recommendation: A QP4 action team should conduct a study to identify, plan and execute corrective actions prior to lengthy production interruptions due to other unsupportable test equipment. Such a plan must be completed to assure wartime/readiness and/or an acceptable surge posture.
- Determine Compatibility and/or Differences Between Gyro Automatic Test Equipment (ATE) and the Manual Test Stations vs. Product Optimization
  - Current Condition: Perform incoming gyro diagnostic test procedure and final acceptance test procedures on the Contraves ATE. Unit performance values are printed out with product specification limits and accept/reject decisions. This same information is recorded and stored on computer hard disks. Note: MANPGB has prime responsibility for the six ATE located in MANPGA, the nine ATE within MANPGB and 11 ATE units found in MANPGC.

There presently is no planned use of the stored historical data. However, RCC personnel believe the manual test stations provide more cost effective, accurate results than the ATE because:

- Manual test stations results are being used for final gyro acceptance criteria if the product fails any ATE test
- The length of duration of the ATE software programs lead MANPGB supervision to feel the equipment is not cost efficient unless at least three of the six ATE units in each RCC are operational (causes production scheduling problems)
- Inconsistencies between the individual ATE stations also causes a concern for possible unreliability

- MDMSC Recommendation: Data from computerized gyro diagnostic and final functional tests should be utilized to determine continuous improvement opportunities in the gyroscope repair activities. Meaningful historical data should be in a usable format to permit QP4 team analysis to identify continuous improvement opportunities.

  The stored data should be used to develop:

  - Test stand capabilities
  - Test stand accuracies
  - Test stand maintenance schedules
  - Test equipment error budgets
  - Test equipment error biasing
  - Product trending
  - Product repeatabilities
  - Special individual test requirements

  The QP4 team analysis could then determine the real compatibility and/or differences between the gyro ATE and manual test stations to allow cost effective utilization of MANPGB responsible equipment resources.

- Rearrange PCN 74051A Test/Repair Area
  - Current Condition: The repair stations are located on a busy traffic aisle between the main building corridor and the sealing area. The test panels are located next to the repair stations on a dead end aisle. The repair operators are subjected to many distractions by the heavy traffic pattern through their area. Both their peers from other areas and various support personnel pass the work stations in performance of their daily tasks.
  - MDMSC Recommendation: Exchange the 010 test/calibration panel line with the repair operators line (PCN 74051A). The move would remove the repair operators from the traffic pattern and its accompanying distractions. The distractions would not impact the test/calibration panel line as severely because concentration span time is shorter and unit run time between adjustments is non-productive but necessary.

    The repair operators will increase their productivity through less distraction and camaraderie from being outside of the traffic pattern. The test operators should not be adversely affected because their task has inherently more non-productive time.
- Analyze Cost Effectiveness of Implementing a Dynamic Gyro Rotor Laser Balancing System for WR-ALC Similar to AGMC
  - Current Condition: During site interviews, it was noted that a Productivity, Reliability, Availability and Maintainability (PRAM) program funded, dynamic gyro rotor laser is scheduled to be installed in the last quarter of 1989 in the AGMC displacement gyroscope wheel repair facility. WR-ALC/MANPG is also planning the implementation of laser balancing their specific gyro rotors.

- MDMSC Recommendation: MANPG at WR-ALC should delay current procurement action on a costly (approximately $250K) Gyro Rotor Laser Balancing System until the AGMC displacement gyro shop has analyzed the true implementation costs and efficiencies involved. In particular, initial concerns expressed involve product surface roughness quality and possible processed material particulate contamination. A time interval between similar projects should be allowed for comparison purposes for the efficient planning, implementation and insertion of high technology such as the subject second laser balancing system.

  A potential improvement opportunity would involve a focal point at WR-ALC to coordinate and expedite the transfer of the high technology laser balancing system knowledge to MANPG/WR-ALC to maximize overall AFLC/MA efficiency.

Operational Improvement Opportunities

- Improve Instrument Bearings Procurement and Handling Procedures
  - Current Condition: Instrument bearings quality related problems impact costs and schedule within MANPG's gyroscope repair activities. Corrosion is frequently evident on packaged bearings when initially received at the MANPG facility. Significant rework/repair costs occur associated with bearing reinspection, scrap efforts and nearly 100% cleaning for salvage.
  - MDMSC Recommendation: AFLC/WR-ALC initiate tighter quality control procedures during receiving inspection operations. Zero defect components from suppliers will reduce repair/assembly labor costs, increase throughput and reduce flow times in WR-ALC gyro repair operations. Also, the methodology of improving supplier reliability could be transferred across the command, avoiding any similar rework costs at AGMC or other bearing users.

- Motorize Dividing Head Stands
  - Current Condition: The manual test stands for directional and vertical displacement gyros are positioned and/or turned through cranking of hand wheels or hand wheel extenders. The hand cranking is laborious and is avoided by the operator using alternate equipment and/or developing methods outside the Technical Order.
    Directional gyros were observed waiting the availability of an alternate test set that was motor driven in one axis. Actual interviews of RCC personnel determined this was preferred to hand cranking the manual dividing heads. A smooth rate was difficult to maintain by the hand cranking method.
  - MDMSC Recommendation: MDMSC recommends the dividing heads of the manual test stands be motorized in both axes. The motor drives should be frictional to eliminate the need for expensive clutching systems and should allow for final positioning by the operator to eliminate encoders and servo systems. The drives should allow for a smooth constant rate but need not be of great accuracy.

    The benefit to be gained is test station capacity and versatility. By removal of the test stand avoidance situation adherence to the Technical Orders will improve. Some cost savings are to be realized by reducing operator fatigue but would be difficult to quantify.

10.3 MANPGC ANALYSIS AND FOCUS STUDY RECOMMENDATIONS

The MANPGC RCC, along with its sister Gyro Section RCCs MANPGA and MANPGB, are responsible for the overhaul and test of various miniature rate, vertical and two axis displacement gyros and flight data instruments. The workload within MANPGC consists of MISTR and exchangeables.

The MDMSC team has developed a good working relationship with the Gyro Unit No. 3 repair operations personnel. Gyro personnel were instrumental in the success of the site survey tasks such as data collection, operation profiles, shop floor interviews and review of facility layouts. This provides the basis to characterize the operation of MANPGC and allows for the identification of process improvement opportunities. MDMSC appreciates the excellent cooperation received from the entire WR-ALC team .

During initial characterization of the MANPGC RCC, a total of ten potential improvement opportunities were identified (reference MANPGC Database Documentation Book, Potential Improvement Opportunities section). After review of this original set of opportunities by the MDMSC/WR-ALC team, five improvement opportunities were selected to be pursued as the focus of the TI-ES Program activities relating to MANPGC.

The first improvement opportunity, a focus study, titled Combine RCCs MANPGA, MANPGB and MANPGC Gyro Rotor Assembly Repair to a Common Line Flow, recommends Inserting a Just-In-Time (JIT) cellular manufacturing environment to improve coordination of MANPG gyro rotor repair activities and substantially reduce flow times and resource requirements. Production/process flexibility and quality will improve a measurable amount as well. This focus study is identified in paragraph 10.3.4 and was previously presented in detail in paragraphs 10.1.4 through 10.1.4.4.

The proposed focus study investigation will allow for a detailed summary of the expected cost savings/benefits to MANPGC repair/remanufacturing operations. Upon completion of the focus study, the As-Is baseline information will be used

to define discrete quantitative as well as qualitative changes that can be made to improve the following:

- Resource Utilization
- Cost
- Quality
- Product Throughput
- Process Flow Time

Four of the improvement opportunities were selected to be presented as quick fixes and are summarized below.

- Improve Random Drift Decisions at MANPGC
  Proposes implementation of a decision panel device which should minimize the testing of defective gyros for a prolonged time.

- Improve Gimbal/Spin Bearing Handling in MANPGA, MANPGB and MANPGC
  Proposes establishing better material handling techniques to increase the yield of bearing refurbishment operations.

- Improve Fixturing the Induction Machines in MANPGA, MANPGB and MANPGC
  Proposes how safety and product quality improvements can be derived from a consistent fixturing methodology for gyro desoldering activities.

- Re-evaluate Need for Diagnostic Checks at All MANPG RCCs
  Proposes that based on historical E046B data, when wheel repair occurrence factors of 90% and greater are noted, a cost benefit can be derived by eliminating the limited value diagnostic testing for certain gyroscopes.

These quick fix opportunities offer significant benefits to MANPGC in terms of quality, time and cost and are described in detail under separate cover, reference Technology Insertion-Engineering Services Process Characterization,

Task Order No. 1, Volume VII Quick Fix Plan WR-ALC, MANPGC Quick Fix opportunities section.

The remainder of the original MANPGC improvement opportunities are presented as other observations and are described in paragraph 10.3.5 of this document.

10.3.1 Description of Current Operations

MANPGC is an RCC under the MANPG section of the Industrial Products Division (MAN) at WR-ALC. MANPGC is located in Building 158. The area is maintained as a Class 300,000 clean room though clean room garb is not required. The primary workload is MISTR work. It consists of a variety of directional gyroscope systems and a number of fluid damped rate and rate switching gyros. Most gyros in the area are of a 1955 to 1965 design. The workload has been decreasing for some time due primarily to product age.

The workload within MANPGC consists of MISTR and exchangeables. MISTR represents greater than 98% of the workload. Table 10.3.1-1 depicts the PCNs involved in the FY 88 80/20 workload analysis. The RCC repairs and tests in

MANPGC GYRO SHOP FY 88 WORKLOAD
TABLE 10.3.1-1

REPRESENTATIVE GYRO FAMILY PCN	FY 88 INDUCTIONS				TOTALS
	1ST QTR	2ND QTR	3RD QTR	4TH QTR	
06121A	149	149	149	149	596
74061A	343	343	343	343	1372
74063A	244	244	244	244	976
74146A	255	255	255	255	1020
74148A	175	175	175	175	700
74149A	169	169	169	169	676

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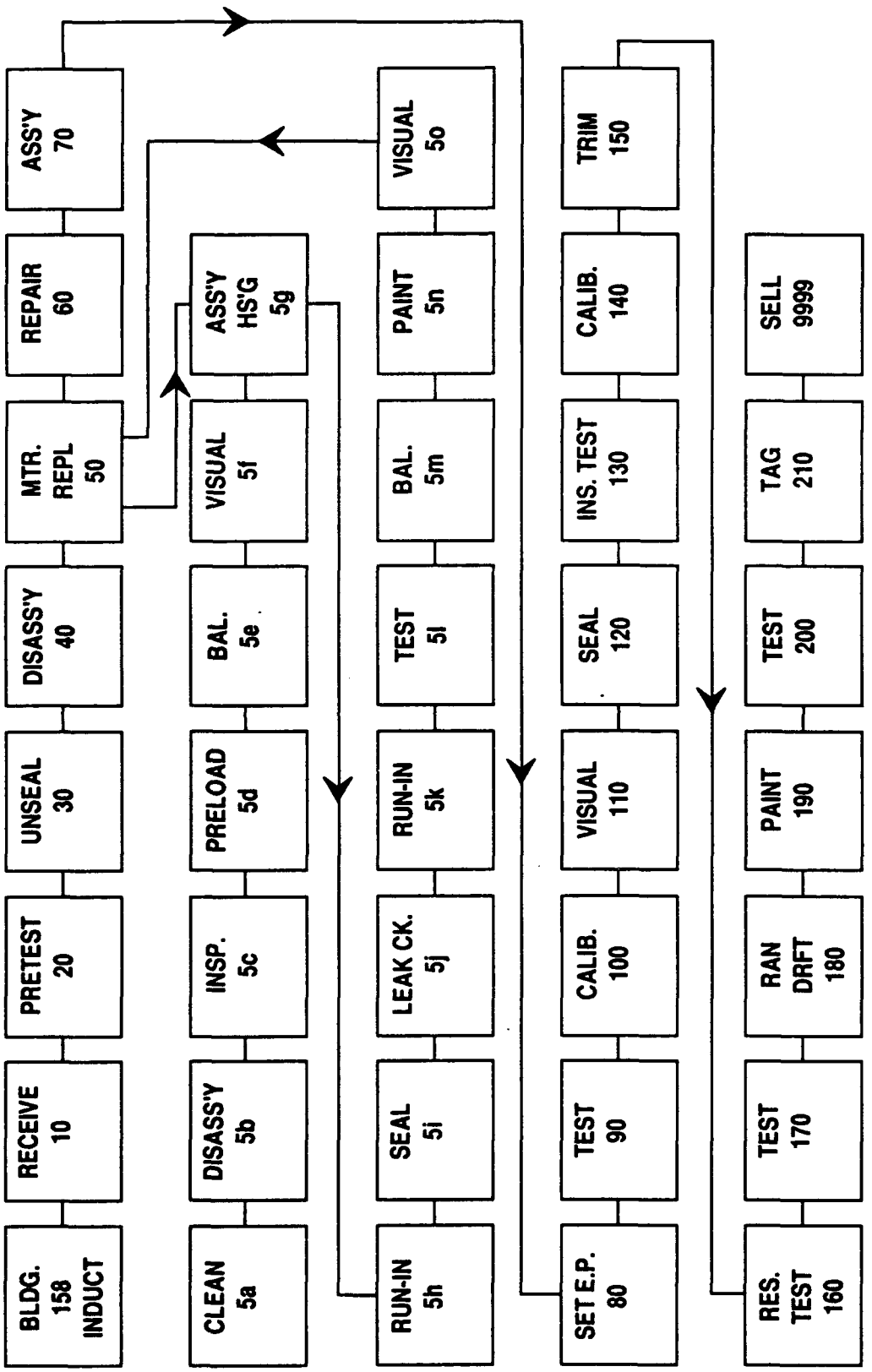
excess of 12,000 units annually. The process of inducting, repairing, and testing of gyros is compatible with like operations in private industry. Figure 10.3.1-1 is a general process flow chart of gyro repair operations most common within MANPGC.

MANPGC equipment consists mainly of individual workbench stations, vacuum and circulating ovens, leak detecting stations, and many manual and semi-programmable test stands. Most of the tooling is standard precision hand tools furnished to the technical operators in complete kit sets. Each separate PCN model does require some special tooling, but little is complex enough to require much concern in this study. The circulating and vacuum ovens are minor adaptions of standard units. The leak detection equipment are standard catalog items such as Veeco or Varian, then adapted to specific model gyros or families of gyros. The test sets and stands except for the Contraves rate test stations are of an age consistent with the product design age. It is doubtful that it can be properly supported much longer. The Contraves test stations are of a more recent design and are closer to state of the art. They are manually programmable and capable of testing a large variety of gyroscopes.

The repair process technologies within MANPGC consist of defining the malfunction causes of gyroscopes, repairing as required, and retesting to verify the completeness of the repair. The gyros are pretested to identify malfunctions, torn down and repaired as required to technical overhaul manuals. Repair is generally accomplished through replacement of worn and/or defective piece parts. The rebuild and acceptance testing is also directed by Technical Orders and test specifications. Some mandatory replacement of high failure items are directed by Technical Orders to extend MTBF. Precision bearing and miniature slip rings/brushes are examples of some 100% replacement parts.

The first step in the gyro repair process is the manual desoldering of the sealed gyro case (cover) to allow removal of the gyro for repair. Shop floor interviews and observations indicate a quick fix opportunity exists to provide proper



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MANPGC CONTROL GYRO PROCESS FLOW CHART
FIGURE 10.3.1-1

fixturing during gyro covers unsealing operations utilizing the induction heater machine. This opportunity is presented in detail in paragraph 10.1.4 of the MANPGA QFP.

In depot repair of gyroscopes, most of the time is spent in testing. Units are diagnostically tested, faulty components replaced and functionally tested. Repair is usually performed by a single technician at a bench-type laminar flow booth work station. Bench repair does not require complex routings and is dedicated to a particular product.

A quick fix opportunity to improve manpower utilization and throughput was observed on PCN 74146A gyro diagnostic testing procedures. Cost benefits can be derived by eliminating the limited value diagnostics test for certain gyroscopes. This quick fix is addressed in detail in paragraph 10.1.5 of the MANPGA QFP.

Another quick fix opportunity, titled Improve Random Drift Decisions at MANPGC, proposes implementation of a decision panel device which would minimize the prolonged testing of defective gyros. This improvement opportunity is addressed in detail in paragraph 10.3.1 of the MANPGC QFP.

After repair and calibration, resealing of the gyro covers is again accomplished by a manual soldering process. The next major process involves the technician pressurizing the gyro with a gas, immersing it into a liquid and performing a gross leak check by a bubble test. If a leak is detected, the unit must be resealed additionally in the area of the visible leaks. After subsequent recycles and successful completion through the gross leak bubble test, the gyro seal integrity is final functional tested on a Veeco vacuum leak detection system.

Conducted in parallel with gyro repair activities, all wheel (gyro rotor) repair process technologies are routinely batch processed in quantities of 10 to 20 units. Figure 10.1.1-2 (previously referenced) is a general process flow chart of MANPGA wheel repair operations. During process characterization efforts in all three MANPG RCCs it was noted that each unit is responsible for several gyro

rotor PCNs and perform the necessary workload's repair process technologies according to individual line and/or technician availability. Focus Study No. 1, will address this problem by determining the feasibility of combining RCCs MANPGA, MANPGB and MANPGC Gyro Rotor Assembly Repair to a Common Line Flow. Improved coordination of MANPG gyro rotor repair activities will substantially reduce flow times and resource requirements. Table 10.1.1-2 summarizes the FY 88 MANPG gyro section workload and quantifies the amount of gyro rotor rebuild activities currently spread throughout all three RCCs. This focus study is presented in detail in paragraphs 10.1.4 through 10.1.4.4.

Material handling in MANPGC is mostly accomplished by the repair operator hand carrying the items between stations. The gyroscopes are small, weighing from ounces to a few pounds. Units are repaired by a single mechanic rather than by line flow process. The one exception of this method is rotor repair, which are repaired in groups rather than one at a time. The repair is still accomplished by a mechanic, not a line, but an operation is completed on multi assemblies before moving to the next operation.

A quick fix opportunity, involving wheel repair operations, is titled Improve Gimbal/Spin Bearing Handling and defines improved material handling techniques to increase the yield of bearing refurbishment operations. This quick fix is presented in detail in paragraph 10.1.3 of the MANPGA QFP.

Storage is on line in MANPGC. It is accomplished on shelved hand trucks between aisles on the repair floor. The items for repair are received, logged in, and placed on the storage trucks for pretest. After pretest, the items are returned to the truck to wait the availability of a mechanic. The item is repaired and calibrated then returned to the truck or another truck for test and ship.

The facility layout drawing of the MANPGC sections of Building 158 does represent the As-Is condition of the facility at the time of the study. The RCC is spread into two locations in Building 158 and shares part of its prime area with

MANPPC which has moved into the area in the last year. It is not maintained consistent with clean room practices.

MANPGC has a stable work force with little variance. The work force is comprised of instrument mechanics, three supervisors, a clerk and a senior supervisor. The following is a breakdown of the mechanics within MANPGC.

Skill Code	Skill Level	Quantity	Experience
WG 3359	G-10	1	25.0 yrs.
WG 3359	G-09	55	20.7 yrs.
WG 3359	G-07	10	7.6 yrs.
WG 7009	G-04	1	12.0 yrs.

It is to be noted that the work force is shared between the gyro RCCs as workloads vary. A major concern is availability of trained instrument mechanics if increased workload was demanded. The age of the work force should also be of a concern. Experience is very high but natural attrition is reducing the numbers faster than training is furnishing younger mechanics. Surge conditions would be gated by this constraint.

10.3.2 Statistical System Performance Measures

MANPGC repairs and tests directional gyroscopes and fluid damped rate and rate switching gyros. The WR-ALC/MDMSC TI-ES team selected PCNs 06121A, 74061A, 74063A, 74146A, 74148A and 74149A to represent a generic family of gyros commonly overhauled in this RCC. The team's process characterization of these gyros included gathering data via:

- Interviews with ALC/RCC personnel
- WCD historical information with scheduling personnel assistance
- Maintenance and production interviews concerning equipment MTBF and MTTR

The profile data sheet information was then transferred to personal computer files using a Lotus 1-2-3 database storage system. After data verification, flat files for this RCC were generated. Simulation runs were then executed utilizing UDOS 2.0.

The WR-ALC/MDMSC TI-ES team, along with an AFLC representative, performed a statistical comparison of the UDOS 2.0 model simulation outputs for the FY 88 MANPGC repair process. The validation was performed by comparing average simulated to average historical flow times and average simulated throughput to FY 88 throughput. The WR-ALC/MDMSC team set a 90% confidence level as minimum acceptance criteria in both areas.

Throughput of MANPGC PCNs were within the 90% confidence level factor. Comparison of average simulated with average historical flow times revealed a substantial difference. After investigation, it was agreed to add a buffer operation to PCNs 06121A, 74063A, 74148A and 74149A. This buffer operation represented the process of inspecting all gyros to determine repair requirements and set them in a staging area until personnel are available to perform the work. The amended input was loaded into the UDOS 2.0 and a second computer run executed. Analysis of the results indicated that both the throughput and flow time elements were within an acceptable range. This simulation model database represents the As-Is condition for FY 88 and is a baseline for comparison purposes. Brainstorming was performed during the model validation of RCC MANPGC. Representatives from production, scheduling, planning, quality and industrial engineering from WR-ALC and MDMSC participated in this session. Suggestions to reduce flow time and increase throughput were discussed and points noted. A "fishbone" (cause and effect) diagram was developed from these suggestions and is graphically depicted in section 9.0 of MANPGC's DDB.

Analysis of the model validation run output revealed that utilization of equipment is very low and manpower is high. Based on this analysis and the brainstorming

session, the WR-ALC/MDMSC TI-ES team agreed to use the following assumptions and control factors to evaluate the effect on throughput.

- Workload for MANPGC will remain the same as FY 88
- No change to manpower quantity
- Changes were made to certain equipment quantities to analyze their impact on throughput and was classified as Base, Base+ and Base++, reference Table 10.3.2-1.

The L_9 Taguchi array was constructed based on the above assumptions and factors and is depicted in Table 10.3.2-2. The table shows the overall throughput percentages for the PCNs that were profiled. The table also lists the individual PCNs which showed the best and worst throughput percentage under each experimental run.

Analysis of output produced by the experimental runs indicates that the throughput of RCC MANPGC are all around 100% at Base+ and Base++ condition. Throughput at Base condition on all the three experiments are around 80%.

Evaluation of all the nine runs for best and worst condition revealed that the worst throughput of 4% occurred at Base condition. At the reduced equipment level, Base condition, MANPGC would have a problem in processing PCN 74148A. A detailed review of PCN 74148A indicates a high initial queue time of approximately 5574 hours for operation 3G (waiting for manpower IG09 and equipment 0002, vacuum oven).

Analysis of experimentation results and engineering assessment during data collection indicated that RCC MANPGC could increase the utilization of equipment by a "common rotor repair cell" concept. This concept is being recommended by MDMSC as a focus study, Gyro Rotor Repair, reference section 10.3.4.

MANPGC CONTROL FACTORS
TABLE 10.3.2-1

BASE			BASE+ (AS-IS)			BASE++		
EQUIP. NO.	EQUIPMENT NAME	EQUIP. QTY.	EQUIP. NO.	EQUIPMENT NAME	EQUIP. QTY.	EQUIP. NO.	EQUIPMENT NAME	EQUIP. QTY.
0002	VACUUM OVEN	6	0002	VACUUM OVEN	12	0002	VACUUM OVEN	12
0787	TEST ASSY	3	0787	TEST ASSY	5	0787	TEST ASSY	5
0844	TEST ASSY	1	0844	TEST ASSY	2	0844	TEST ASSY	2
3346	LEAK DETECTOR	3	3346	LEAK DETECTOR	6	3346	LEAK DETECTOR	6
5509	RATE TEST	2	5509	RATE TEST	4	5509	RATE TEST	4
8437	TESTER	1	8437	TESTER	2	8437	TESTER	2
9015	GYRO TEST	2	9015	GYRO TEST	4	9015	GYRO TEST	4
9036	DIRECT TEST SET	2	9036	DIRECT TEST SET	4	9036	DIRECT TEST SET	4
9058	TEST PANEL	1	9058	TEST PANEL	2	9058	TEST PANEL	2
9420	TEST SET	2	9420	TEST SET	4	9420	TEST SET	4
			IG09	MANPOWER	55	IG09	MANPOWER	60

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MANPGC GYRO SHOP TAGUCHI ORTHOGONAL ARRAY

TABLE 10.3.2-2

RUN #	FACTORS & LEVELS						WORKLOAD (THROUGHPUT)		
	MANPOWER			OVERTIME		EQUIPMENT	INDUCTIONS: 5299: 130% OF FY 88		
	1	2	3	SAT	SUN		AVG.	BEST	WORST
1	ALL					BASE	80.3 %	74061A 101.0 %	74148A 4.0 %
2	ALL			YES		BASE +	98.6 %	74146A 100.4 %	74149A 97.5 %
3	ALL			YES	YES	BASE ++	99.2 %	74146A 100.3 %	74149A 97.0 %
4	50%	50%				BASE ++	99.2 %	74146A 100.0 %	74149A 97.5 %
5	50%	50%		YES		BASE	81.2 %	74063A 100.0 %	74148A 5.0 %
6	50%	50%		YES		BASE +	98.9 %	74146A 100.0 %	74149A 97.5 %
7	1/3	1/3	1/3			BASE +	99.0 %	74146A 100.0 %	74149A 97.5 %
8	1/3	1/3	1/3	YES	YES	BASE ++	99.0 %	74146A 100.0 %	74149A 97.6 %
9	1/3	1/3	1/3	YES	YES	BASE	80.2 %	74061A 100.0 %	74148A 6.0 %
SURGE*	50%**		50%**			BASE +	98.0 %	74061A 100.2 %	74063A 97.5 %

NOTES:
* INDUCTIONS = 4270 (159 % OF FY 88 - 2 QTRS)
** TWO 12 HOUR SHIFTS.

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To evaluate the RCC MANPGC capability to respond to surge condition, the following assumptions were agreed to by WR-ALC/MDMSC team.

- Same manpower as in FY 88
- Spread the manpower between two 12 hour shifts - five days a week
- Increase the FY 88 workload by 159%, which is the average of surge factor provided by AFLC for weapon system serviced by WR-ALC Gyro shop.

An experimentation run was executed with above assumptions for two quarters. The average throughput analysis indicates that RCC MANPGC has the capability to meet surge condition.

10.3.3 Description of Process Problems

The intent of this paragraph is to expound on major process problems for which there are focus study recommendations. The focus study, Combining Gyro Rotor Assembly Repair to a Common Line Flow, is designed to improve performance within the MANPG gyro RCCs and is presented in detail in this document in MANPGA paragraph 10.1.4.

10.3.4 Recommended Focus Study: Combine RCCs MANPGA, MANPGB and MANPGC at WR-ALC Gyro Rotor Assembly Repair to a Common Line Flow

Refer to paragraphs 10.1.4 through 10.1.4.4.

10.3.5 Other Observations

The other observations described in this section were not considered as focus studies or quick fixes because they had a less significant impact on the areas of time, quality, or cost. These observations are recorded to assist WR-ALC in developing ideas that will further enhance their operations.

The observations which follow were originally identified as Quick Fix and Focus Study improvement opportunities and are detailed as such in the MANPGC

DDB. After review by the MDMSC/WR-ALC TI-ES team, it was mutually agreed that they should be presented as other observations for future reference.

Management Improvement Opportunities

- Evaluate Obsolescence of Old Bench Test Sets
  - Current Condition: It was observed that many of the line or bench test sets are difficult to support because of obsolescence. Surge conditions will experience problems from this condition and possibly from a lack of trained gyro technicians due to disappearing workload and natural attrition.
  - MDMSC Recommendation: A QP4 action team should conduct a study to identify, plan and execute corrective actions prior to lengthy production interruptions due to other unsupportable test equipment. Such a plan must be completed to assure wartime/readiness and/or an acceptable surge posture.
- Analyze Cost Effectiveness of Implementing a Dynamic Gyro Rotor Laser Balancing System for WR-ALC Similar to AGMC
  - Current Condition: During site interviews, it was noted that a Productivity, Reliability, Availability and Maintainability (PRAM) program funded, dynamic gyro rotor laser is scheduled to be installed in the last quarter of 1989 in the AGMC displacement gyroscope wheel repair facility. WR-ALC/MANPG is also planning the implementation of laser balancing their specific gyro rotors.
  - MDMSC Recommendation: MANPG at WR-ALC to delay current procurement action on a costly (approximately $250K) Gyro Rotor Laser Balancing System until the AGMC displacement gyro shop has analyzed the true implementation costs and efficiencies involved. In particular, initial concerns expressed involve product surface roughness quality and possible processed material particulate contamination. A time interval between similar projects should be allowed for comparison purposes for the efficient planning, implementation and insertion of high technology such as the subject second laser balancing system.

A potential improvement opportunity would involve a focal point at WR-ALC to coordinate and expedite the transfer of the high technology laser balancing system knowledge to MANPG/WR-ALC to maximize overall AFLC/MA efficiency.

Operational Improvement Opportunities

- Improve Instrument Bearings Procurement and Handling Procedures
  - Current Condition: Instrument bearings quality related problems impact costs and schedule within MANPG's gyroscope repair activities. Corrosion is frequently evident on packaged bearings when initially received at the MANPG facility. Significant rework/repair costs occur associated with bearing reinspection, scrap efforts and nearly 100% cleaning for salvage.
  - MDMSC Recommendation: AFLC/WR-ALC initiate tighter quality control procedures during receiving inspection operations. Zero defect components from suppliers will reduce repair/assembly labor costs, increase throughput and reduce flow times in WR-ALC gyro repair operations. Also, the methodology of improving supplier reliability could be transferred across the command, avoiding any similar rework costs at AGMC or other bearing users.

Technology Improvement Opportunities

- Motorize Dividing Head Stands
  - Current Condition: The manual test stands for directional and vertical displacement gyros are positioned and/or turned through cranking of hand wheels or hand wheel extenders. The hand cranking is laborious and is avoided by the operator using alternate equipment and/or developing methods outside the Technical Order.

    Directional gyros were observed waiting the availability of an alternate test set that was motor driven in one axis. Actual interviews of RCC personnel determined this was preferred to hand cranking the manual dividing heads. A smooth rate was difficult to maintain by the hand cranking method.

- MDMSC Recommendation: MDMSC recommends the dividing heads of the manual test stands be motorized in both axes. The motor drives should be frictional to eliminate the need for expensive clutching systems and should allow for final positioning by the operator to eliminate encoders and servo systems. The drives should allow for a smooth constant rate but need not be of great accuracy.

  The benefit to be gained is test station capacity and versatility. By removal of the test stand avoidance situation adherence to the Technical Orders will improve. Some cost savings are to be realized by reducing operator fatigue but would be difficult to quantify.

- Improve Removal of the Gyro Case on PCN 06121A
  - Current Condition: The cover is mechanically pierced and peeled off the gyro base. The cover is scrapped. Present method destroys the drawn gyro cover.
  - MDMSC Recommendation: Apply controlled air pressure to the vent tube until cover pops loose. Set aside for reuse on repaired gyro. Actual interviews and demonstration by line personnel of the ease of disassembly with air pressure verified the usability of removed cover.

    The proposed method also eliminates the risk of possible injury to the operator from sharp metal edges caused from piercing and peeling.

10.4 MANPSA ANALYSIS AND FOCUS STUDY RECOMMENDATIONS

MANPSA is an RCC within the MANPS section of the Industrial Products Division (MAN) at WR-ALC. MANPSA is located in Building 169.

The workload within MANPSA consists of mostly Management of Item Subject to Repair (MISTR) items with a small amount of Programmed Depot Maintenance (PDM) work. The primary workload in MANPSA consists of repair of C-141 ailerons under a PDM program, and MISTR work consisting of adhesive bonding on C-141 petal doors, access doors, ailerons, leading edge, horizontal stabilizer, and the F-15 speed brake.

During initial characterization of the MANPSA RCC, a total of 24 potential improvement opportunities were identified (reference MANPSA Database Documentation Book, Potential Improvement Opportunities section). After review of this original set of opportunities by the MDMSC/Air Force team, twelve improvement opportunities were selected to be pursued as the focus of the TI-ES Program activities relating to MANPSA. After further review the remaining six possible focus studies were deferred or combined and included in the recommended MANPSA focus study. The deferred ones may be reinstituted at any time in the future at the concurrence of the AFLC.

The following improvement opportunities have been deferred by the WR-ALC TI-ES Team:

- Facilities layout study, Building 169.
- Facilities layout study, Building 603.
- Facilities layout study, Building 607.
- Study to make a computerized workbook (Work Control Document (WCD)).
- Study for CADAM data storage and usage - Similar systems currently in use at WR-ALC.
- Study to complement the WR-ALC LIFT plan.

The following improvement opportunities have been combined into Focus Study No. 2 for MANPSA RCC.

- Feasibility study for WR-ALC to manufacture C-141 petal door inner/outer skin assemblies in-house
- Tooling jig/fixture study for MANPSA RCC (Aileron and Petal Door)

Two of the improvement opportunities were selected to be presented as focus studies. One focus study, titled "Redesign and Modification of Existing C-141 Aileron Check Fixture," proposes modification of the present check fixture for use as both a working jig and a check fixture. This focus study is presented in paragraphs 10.4.4 through 10.4.4.4. The other focus study, titled "Redesign and Modification of Existing C-141 Petal Door Working Jigs," proposes modifying the present working jigs to eliminate unnecessary handlings. This focus study is presented in paragraphs 10.4.5 through 10.4.5.4. The focus study entitled "C-141 Aileron, Petal Door, and Aft Cowl Tooling," as presented in paragraph 10.6.5 proposes the uniting of the two RCC MANPSA focus studies as outlined above with the one RCC MANPSC focus study described in paragraph 10.6.4 as the most cost effective way to study all three of the C-141 subject jig/fixture design usage.

The ten quick fixes applicable to RCC MANPSA are summarized below.

- <u>Develop a Mechanic's Handbook for Each Repaired Assembly</u>
  Proposed to compliment and supplement the Technical Orders and document all major steps and techniques of each repaired assembly unit. The manual would be invaluable to new or less experienced mechanics in a rapid build-up surge or war-time readiness situation or where a production rate increase would be necessary, such as the present F-15 wing repair effort.

- Implement Program for the Mechanic to Buy and Maintain Own Hand Tools

  Proposed to eliminate/reduce the number of tools/boxes/stands, tool crib manpower and buying activity and expense. The plan will provide the necessary tools and make the worker responsible for the tool inventory and the replacement of broken hand tools.

- Move Bond Mechanics Closer to the Autoclaves

  Proposed to reduce time lost by mechanics who work/repair bonded assemblies going back and forth from the mechanics home station.

- Provide Level Aileron Support Tables

  Proposed to make tables the same height to support the ailerons to eliminate the time needed to make these level until a better holding fixture can be provided.

- Provide Pictorial Drawings With the Existing Workbooks (WCDs)

  Proposed to assist the worker to better understand the required task and to help train others in a surge or war-time emergency situation.

- Design/Build an Aileron Tab Hinge Locator

  Proposed to aid the mechanic in the replacement and correct shimming of the aileron tab hinge fittings on the C-141 aileron rear beam. This is difficult to do using the tab assembly as a tool because the tab leading edge is in the way.

- Design/Build a Type of a Newspaper Clipping Cutter

  Proposed for the mechanic to use to assist the cutting of thin (.005) skins on the C-141 horizontal stabilizer leading edges. This tool is also similar to a tool used to cut wood veneers. This new tool will replace the current cumbersome method of having to use unwieldy type makeshift tools such as a can opener.

- Certify the Mechanic Repairing the C-141 Horizontal Stabilizer Leading Edges
  Proposed to certify the mechanic in the use of an ohmmeter and brazing units to check the continuity of the wiring and the mesh heating elements. This will eliminate the mechanic from making at least four trips to the back shop for repair verification.

- Make Available Cobalt-Tipped Drill Bits, or Equivalent
  Proposed in lieu of resharpened drill bits, for the mechanic's use to drill out aluminum rivets and other type fasteners such as steel bolts and blind steel rivets.

- Combine Repair Operations per the C-141 Aft Cowl Door
  Proposed to reduce the number of mechanics required to perform the aft cowl door repair from two to one mechanic.

These quick fixes offer benefits to MANPSA in terms of quality, time, and cost and are described in detail under separate cover, reference TI-ES Task Order No. 1, Volume VII, Quick Fix Plan, WR-ALC MANPSA, Quick Fix Opportunities section for their descriptions.

The remainder of the original MANPSA improvement opportunities are presented as other observations and are described in paragraph 10.4.6.

10.4.1 Description of Current Operations

The repair process technologies within MANPSA consist of major unit manufacturing and small sheet metal conventional, honeycomb bonded and composite repairs on high value C-130, C-141 and F-15 major aircraft assemblies. These assemblies are critical to flight safety and the performance of the aircraft in their assigned mission. Table 10.4.1-1 depicts the part control numbers involved in the 80/20 analysis of the FY 88 workload for RCC MANPSA.

MANPSA SHEET METAL SHOP FY 88 WORKLOAD
TABLE 10.4.1-1

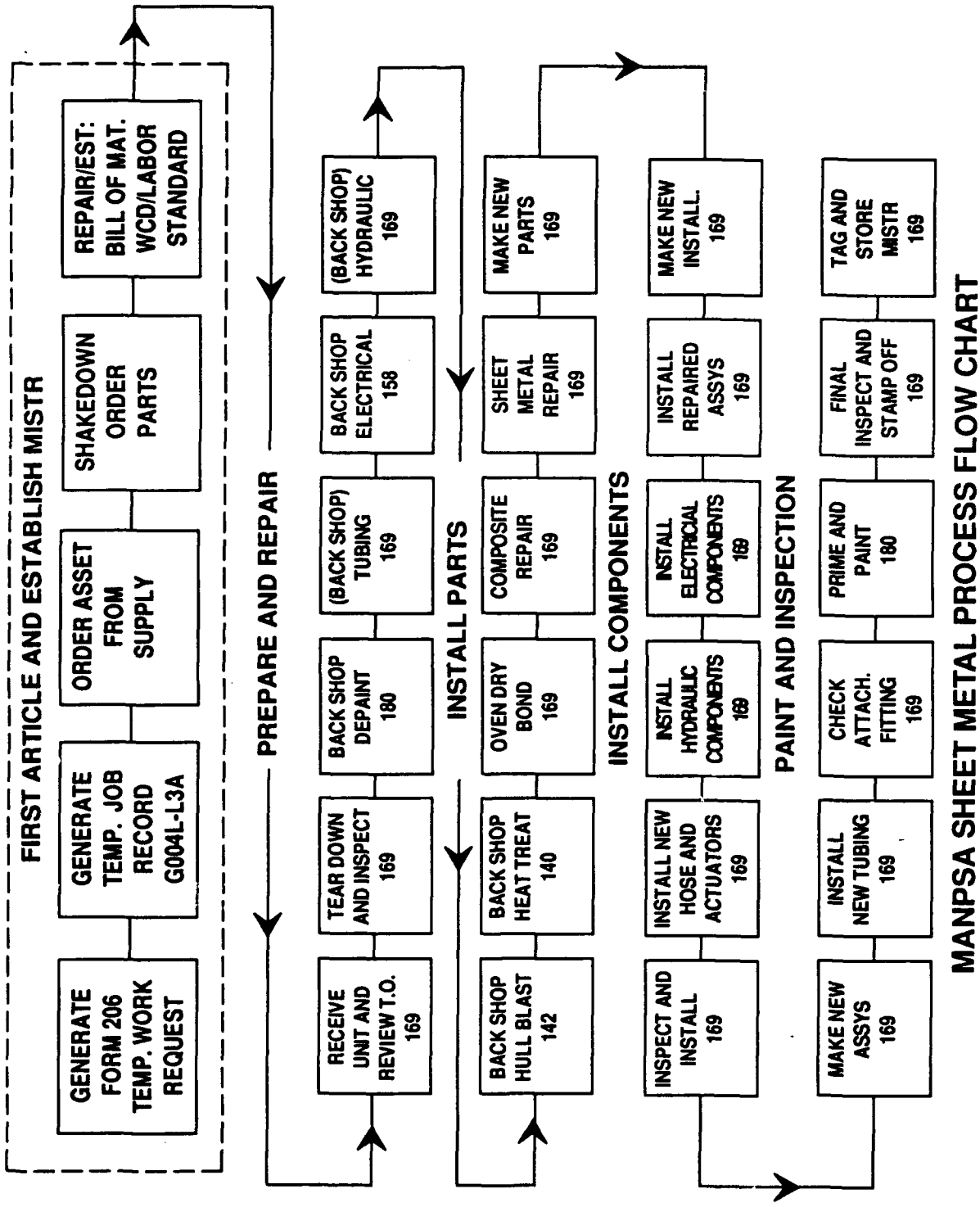
PART CONTROL NUMBER (PCN)	FY 88 INDUCTIONS				TOTALS
	1ST QTR	2ND QTR	3RD QTR	4TH QTR	
01900A	6	11	20	11	48
05502A	17	15	22	23	77
51334A	0	3	3	5	11
51352A	74	26	54	26	180
51418A	10	13	13	8	44
51454A	8	9	8	10	35

LSC-20297A

All of the aircraft assemblies to be inspected and repaired are received in Building 169 and are disassembled as required per the applicable technical order for inspection/repair/modification. Figure 10.4.1-1 is a general sheet metal process flow chart for RCC MANPSA. They are reworked to incorporate all the aircraft modifications and technical order changes to meet the required configuration for the aircraft.

The sheet metal and composite components are repaired to a serviceable condition, otherwise they are replaced on the aircraft with new parts. The repairs may consist of removing local corrosion, replacing damaged sections and those sections with major corrosion, replacing angles, brackets, rivets, fabricating special repair plates, etc. to repair damaged members of the minor or major structural components of the unit.

MANPSA is comprised mainly of conventional sheet metal and certain specialized composite material fabrication equipment. MANPSA has large assembly and check fixtures, rivet installation holding fixtures, fixed tables and dollies, overhead lifting cranes, transport dollies, drying ovens, autoclaves,



MANPSA SHEET METAL PROCESS FLOW CHART

FIGURE 10.4.1-1

LSC-20235

necessary equipment for autoclave support and other ordinary support equipment. MANPSA also has the normal sheet metal equipment to support the PDM/MISTR workload such as hand brakes, hand formers, drill press, band saw, hole punch, bench grinder, as well as all the rivet driving and upsetting tools necessary to support the numerous type of fasteners used in repair/overhaul work.

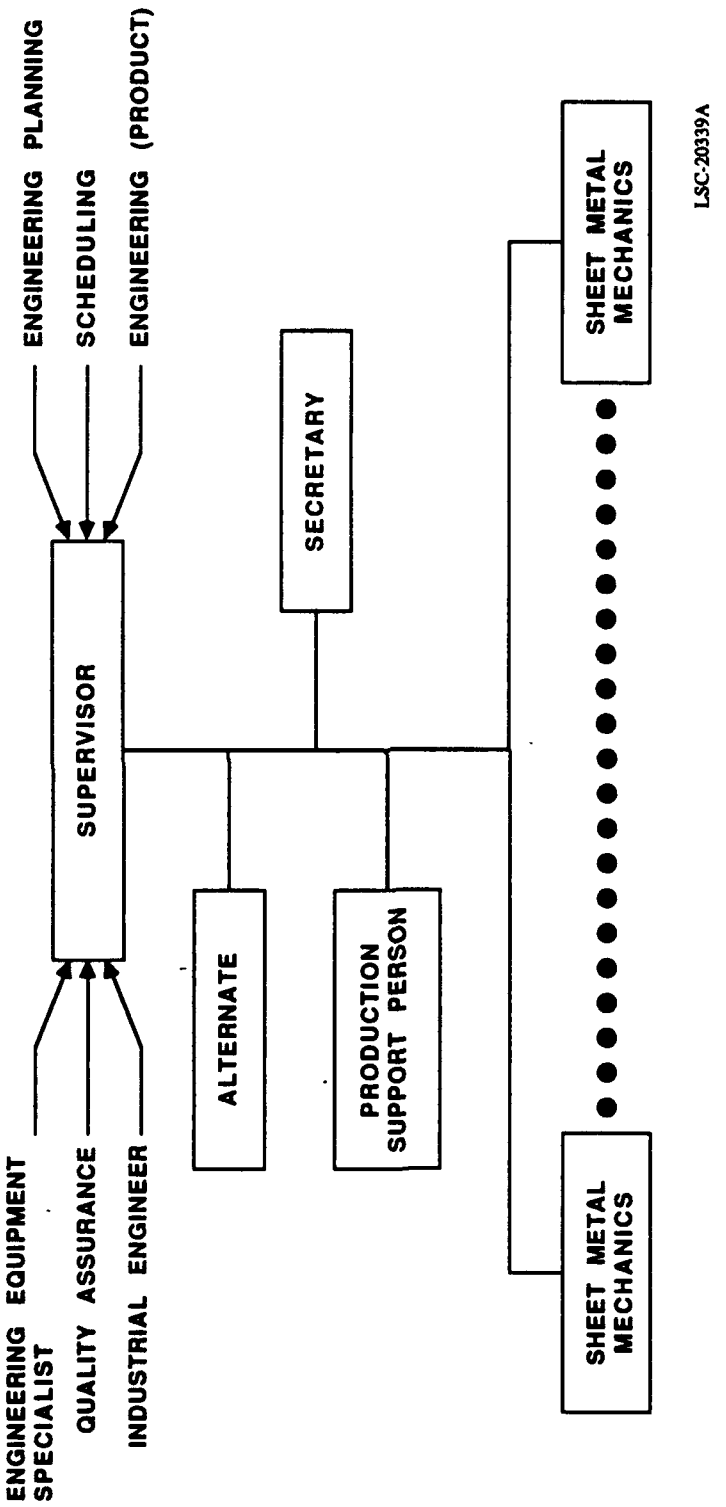
The majority of the equipment within MANPSA varies in age between ten and 20 years old, with some 40 or more years old. The majority of the equipment is in good working condition. New, replacement pieces of equipment are being planned for purchase within the next ten years.

The facility layout drawings of Building 169 represent the existing As-Is condition. The drawings entitled Master Shop Layout File Building 169, were updated as of April 1989 and are of good quality.

MANPSA is headed by a unit chief with five supervisors. The unit chief reports to a section chief. The supervisors and their designated alternates are knowledgeable of the end items and the repair process.

MANPSA has a less than adequate work force. Other RCC areas such as the F-15 Wing Repair has priority over the MANPSA work and has drawn people from the MANPSA effort. The remaining work force is well trained and well supervised. Personal interviews and the interviewees attendance at several "Quality Circle" and "QP4" meetings has indicated a sense of professionalism and pride among the work force. The work force is comprised mainly of the following: aircraft sheet metal mechanics of three basic classifications; metal bond, autoclave, and the general sheet metal type, two foreman classifications, one leader in training, a secretary, a tool and parts attendant, and a worker trainee. Figure 10.4.1-2 shows the typical organization chart.

MANPSA is complimented with good planning and scheduling departments. The MIC and tool crib work closely with supervisors to meet their needs and requirements.



TYPICAL MANPS RCC ORGANIZATION CHART

FIGURE 10.4.1-2

Material handling in MANPSA involves the use of overhead cranes, slings, manpower, holding, and transport dollies, and work carts. All the large and heavy items, such as the C-141 Petal Doors and the Ailerons, etc. are loaded into and out of the check and assembly jigs and fixtures by the use of cranes and slings. Some of the assemblies are manually moved and/or flip-flopped or taken in and out of the jig or fixture as much as six or seven times before completion requiring several workers.

All work is moved, as required, by the mechanic work force. Some moves are made with the overhead crane and sling, but the majority of material handling is done by manhandling or using work dollies with wheels.

The only dedicated storage in the MANPSA area is several parts handling and storage bins in the Aileron and Petal Door areas. Large assemblies such as the Petal Door Skins are stored within the work area, making it difficult to work. The large items not being used should be returned to outside storage, and not stored in Building 169. The skins and other large, bulky items are normally stored in wooden crates outside the MANPSA area.

10.4.2 Statistical System Performance Measures

MANPSA RCC performs conventional sheet metal repair work and adhesive bonding work for C-141, C-130 and F-15 aircraft. The WR-ALC/MDMSC TI-ES team selected PCNs 51454A, 01900A, 51352A, 51418A, 05502A, and 51334A to represent the typical repair work performed in this RCC. The team's process characterization of these PCNs included gathering data via:

- Interviews with ALC/RCC personnel.
- WCD historical information with scheduling personnel assistance.
- Maintenance and production interviews concerning equipment MTBF and MTTR.

This profile data sheet information was then transferred to personal computer files using a Lotus 1-2-3 database storage system. After data verification, flat files for this RCC were generated. Simulation runs were then executed utilizing UDOS 2.0.

The WR-ALC/MDMSC TI-ES team, along with an AFLC representative, performed a statistical comparison of the UDOS 2.0 model simulation outputs for the FY 88 MANPSA repair process. The validation was performed by comparing average simulated flow times to historical flow times and average simulated throughput to FY 88 throughput. The WR-ALC/MDMSC team set a 90% confidence level as minimum acceptance criteria in both areas.

Throughput of MANPSA PCNs were within the 90% confidence level factor. Comparison of average simulated with average historical flow time revealed a significant difference. The main reason for the flow time difference was back shop flow time. ALC/MDMSC reviewed the back shop hours for all the PCNs with AFLC representatives and changed the interview hours to historical hours. After implementing these changes the model output was reviewed and found to be within the criteria limits. The results are discussed in detail in section 6.0 of the DDB for MANPSA. The statistics then generated by the simulation model were within an acceptable range when compared to the As-Is condition. This simulation model database represents the As-Is condition for FY 88 and is a baseline for comparison purposes.

Brainstorming was performed during the model validation of RCC MANPSA. Representatives from production, scheduling, planning, quality, and industrial engineering from WR-ALC and MDMSC participated in this session. Suggestions to reduce flow time and increase throughput were discussed and points noted. A "fishbone" (cause and effect) diagram was developed from these suggestions and is graphically depicted in section 9.0 of MANPSA's DDB.

The WR-ALC/MDMSC TI-ES team agreed to use the following assumptions and control factors to evaluate the effect on throughput.

- Workload for MANPSA will be 130% of FY 88.
- No change to manpower quantity.
- Following changes were made to analyze their impact on throughput and were classified as a Base, Base+, and Base++ (reference Table 10.4.2-1).

MANPSA CONTROL FACTORS
TABLE 10.4.2-1

BASE	BASE+	BASE++
• INCREASE FY 88 WORKLOAD BY 130%. • ALL OTHER FACTORS REMAIN IN THE AS-IS CONDITION.	• INCREASE FY 88 WORKLOAD BY 130%. • WRITE PSUEDO WCD FOR C-141 AILERON - PCN 05502A. • MODIFY 1 SET (QTY 2) OF FIXTURE PM9450. • DESIGN & BUILD CHECK BAR.	• INCREASE FY 88 WORKLOAD BY 130%. • WRITE PSUEDO WCD FOR C-141 AILERON - PCN 05502A. • MODIFY 1 SET (QTY 2) OF FIXTURE PM9450. • DESIGN & BUILD CHECK BAR. • BUILD TWO MORE SETS (QTY 4) NEW FIXTURES FOR PCN 05502A.

LSC-20610

The L_9 Taguchi Array was constructed based on the above assumptions and factors and is depicted in Table 10.4.2-2. The table shows the overall throughput percentages for the PCNs that were profiled. The table also lists the individual PCNs which showed the best and worst throughput percentage under each experimental run.

Analysis of the experimental runs indicate throughputs at base condition (As-Is condition) were around 100%. But, throughputs at both Base+ and Base ++ were between 87% and 96%. With modified fixture and pseudo WCD for aileron at Base+ and Base ++ the throughput were expected to be higher than base condition. A review of best and worst PCNs revealed that PCN 05502A (C-141 aileron) was queued up for resource. Further investigation showed that the new modified fixture is being utilized 100% by the pseudo WCD. Additional quantity of modified fixture does increase the throughput. This was evident when throughput of PCN 05502A was compared between Base+ and Base++. Based on these analyses, a focus study was recommended to modify the fixture to increase the utilization of fixture and then implement this modification with the revised pseudo WCD.

RCC MANPSA was evaluated to determine the capability to respond to surge condition. The following assumptions were considered by the WR-ALC/MDMSC team.

- Same manpower as in FY 88.
- Same equipment as in Base condition.
- Spread the manpower between two 12-hour shifts, five days a week.
- Increase the FY 88 workload by surge factor provided by AFLC for weapon system serviced by WR-ALC.

An experimentation run was executed with the above assumptions for four quarters. Review of output shows that this RCC will have a problem in meeting surge requirement, especially PCN 51454A, C-141 petal door. A larger manpower allocation is required, particularly WG-10, to meet the surge requirement.

MANPSA SHEET METAL SHOP TAGUCHI ORTHOGONAL ARRAY

TABLE 10.4.2-2

RUN #	FACTORS & LEVELS						WORKLOAD (THROUGHPUT)		
	MANPOWER			OVERTIME		EQUIPMENT	INDUCTIONS: 514: 130% OF FY 88		
	1	2	3	SAT	SUN		AVG.	BEST	WORST
1	ALL					BASE	103.0 %	51352A 117 %	51454A 84 %
2	ALL					BASE +	87.0 %	51352A 115 %	05502A 8 %
3	ALL			YES	YES	BASE ++	93.0 %	51352A 115 %	05502A 38 %
4	50%	50%				BASE ++	96.0 %	51352A 116 %	05502A 53 %
5	50%	50%				BASE	103.0 %	51352A 114 %	51454A 84 %
6	50%	50%		YES	YES	BASE +	91.0 %	51352A 115 %	05502A 24 %
7	1/3	1/3	1/3			BASE +	87.0 %	51352A 115 %	05502A 8 %
8	1/3	1/3	1/3			BASE ++	101.0 %	51352A 114 %	05502A 82 %
9	1/3	1/3	1/3			BASE	103.0 %	51352A 115 %	51454A 77 %
SURGE*	50%**	50%**				BASE	90.1 %	51352A 109 %	51454A 43 %

NOTES:
* INDUCTIONS = 1215 (4 QTRS)
** TWO 12 HOUR SHIFTS.

LSC-20612

The WR-ALC TI team reviewed the Block I CSR report for MANPSA RCC. WR-ALC TI team requested additional computer model runs to evaluate the Base, Base+, and Base++ conditions as set forth in Table 10.4.2-3 as it affects the throughput of PCN 05502A.

In response to our WR-ALC/MDMSC team member, the following assumptions were made (reference Table 10.4.2-3).

MDMSC executed three model runs based on above assumptions and the results are tabulated in Table 10.4.2-4. The table shows the average throughput of RCC MANPSA, throughput of PCN 05502A and average simulated flow hours for PCN 05502A.

Comparison of the results indicates that given a constant workload and work force, the throughput of PCN 05502A actually declined when run under test conditions. However, the modification of the aileron fixture is still a viable improvement to the repair process of PCN 05502A because it improves the quality of the end item and ease of operation as described in MANPSA focus study titled "Improve Utilization of Aileron Fixture (C-141)."

10.4.3 Description of Process Problems

The process problems associated with the current MANPSA repair and refurbishment work are interrelated-type problems that usually impact performance. They are defined as inadequate space, lack of/or inadequately trained manpower, inadequate equipment or hand tools, and inefficient working jigs.

Supervision or lack of proper directing does not appear to contribute to the problem.

MANPSA REVISED CONTROL FACTORS
TABLE 10.4.2-3

BASE	BASE+	BASE++
• INCREASE FY 88 WORKLOAD BY 130%.	• INCREASE FY 88 WORKLOAD BY 130%.	• INCREASE FY 88 WORKLOAD BY 130%.
• ALLOCATE ALL MANPOWER TO FIRST SHIFT.	• ALLOCATE ALL MANPOWER TO FIRST SHIFT.	• ALLOCATE ALL MANPOWER TO FIRST SHIFT.
• ALL OTHER FACTORS REMAIN IN THE AS-IS CONDITION.	• REVISE PSUEDO WCD FOR C-141 AILERON - PCN 05502A.	• REVISE PSUEDO WCD FOR C-141 AILERON - PCN 05502A.
	• DESIGN & BUILD CHECK BAR.	• DESIGN & BUILD CHECK BAR.
	• BUILD ONE SET (QTY 2) OF FIXTURE PM9450.	• BUILD THREE MORE SETS (QTY 6) NEW FIXTURES FOR PCN 05502A.

NOTE: REVISED PSUEDO WCD - PCN 05502A RESULTS FROM THE MODIFIED FIXTURE USED AT OP. 265 INSTEAD OF OP. 400. REVISED PSUEDO WCD IS DEPICTED IN SECTION 6.0 OF MANPSA DDB. LSC-20611

MANPSA SHEET METAL SHOP MODEL RESULTS
TABLE 10.4.2-4

RUN #	FACTORS & LEVELS						AVG.	05502A	05502A
	MANPOWER			OVERTIME		EQUIPMENT			
	1	2	3	SAT	SUN		THROUGHPUT	THROUGHPUT	FLOW TIME
1	ALL					BASE	522	93	1219
2	ALL					BASE +	466	25	4923
3	ALL					BASE ++	517	80	1956

LSC-20613

The current method of man-handling and flip-flopping the large, high-value assemblies such as the Petal Doors and the Ailerons for the C-141 is not good. It subjects the skin surfaces to damage that could be prevented by providing a holding fixture which would allow the part to be rotated and locked (index plate) in place while work is being performed.

10.4.4 Recommended Focus Study: RCC MANPSA/WR-ALC to Redesign and Modify the Existing C-141 Aileron Check Fixture to Make a Working Jig in Lieu of Being Solely a Check Fixture

This focus study will provide a detailed investigation and analysis of the Aileron repair process technology, depaint/clean, disassemble, repair, modification, inspection and repaint.

The Aileron focus study will determine improved methods to increase the approximate 15% current jig utilization. It will also determine the optimum quantity of additional jigs to increase throughput for war time surge requirements.

Table 10.4.4-1 details the areas that will be affected by this focus study. Also shown is the MDMSC assessment of the level of effort required in the focus study to evaluate individual areas of analysis.

10.4.4.1 Rationale Leading to Change

The repairing of the C-141 Aileron left hand and right hand assemblies in Building 169 at WR-ALC requires a flow time of 66 days each and a process time somewhere in excess of 420 manhours, with a yearly induction of 101 units (for 1988/1989).

The current method of repairing and refurbishing the C-141 Ailerons involves an excessive amount of manhandling due primarily to the low usage of the present jig/fixture. The present jig is currently used only as an aileron hinge line/position check fixture and as a holding fixture to allow the aileron front beam to be taper shim modified to accept the aileron actuator power package in its properly aligned position.

AILERON FOCUS STUDY NO. 2 CRITERIA CHECKLIST

TABLE 10.4.4-1 (SHEET 1 OF 2)

AREA OF ANALYSIS	ACTIVITY (WHAT & HOW)	LEVEL OF EFFORT		
		MIN	AVG	MAX
Process/Material Flow	The process time will decrease due to the increased usage of the jig, 15% vs ~80%, and the number of additional jigs to provide optimum vs. required workload will be determined.			X
Equipment/Work Place Layout	The new jigs/tools/layout will improve throughput productivity due to the dedicated work place and workstation(s). New work place layouts will be made to maximize full utilization of all equipment and work places.			X
Facility Requirements	The existing facility/space requirements in Building 169 should not change.		X	
Labor Standards	The existing labor standards (WCDs, etc.) will require revisions to show best utilization of all pay labor grades in MANPSA RCC.		X	
Manpower	The manpower requirements should be reduced and/or existing manpower used to better advantage.			X
Task Assignments	All task assignments will change due to the additional equipment. This will be fully explored in the study to define maximum benefits.	X		
Material Requirements	The material requirements will not change. The same repair schemes will be used.	X		
Scrap Rates	No changes anticipated.	X		

LSC-20290A

AILERON FOCUS STUDY NO. 2 CRITERIA CHECKLIST

TABLE 10.4.4-1 (SHEET 2 OF 2)

AREA OF ANALYSIS	ACTIVITY (WHAT & HOW)	LEVEL OF EFFORT		
		MIN	AVG	MAX
Material Handling & Storage Methods	The aileron units will be moved and positioned by overhead crane and sling in lieu of manhandling. The entire handling and storage will be reviewed.			X
Inspection Techniques	Inspection operations remain the same.	X		
Equipment/Tools/Fixtures	The new jigs/tools/fixtures and tooling system will improve work efficiency and increase throughput. This is the main thrust of the focus study.			X
Process Delays	None expected.	X		
Part Identification	No changes anticipated.	X		
Quality	The reduced handling and better access will improve quality of repair.		X	
Personnel Safety	The reduced handling by mechanics in lieu of overhead/crane/sling will make for a safer environment.			X
Environmental Assessments	No changes anticipated.	X		

LSC-20290A

Although the check fixture is used primarily for hinge checking and alignment, it has the potential, due to the massive construction of the fixture, of being modified and used as a working jig to hold the aileron the entire time while it is being repaired and modified

The current method of man-handling and flip-flopping the large, high value assemblies such as the C-141 ailerons, is not good. It subjects the skin surfaces to damage and scratches that could be prevented by providing a holding fixture that would allow the part to be easily rotated and locked with an index plate while work is being performed.

Currently the support tables that are being used are not all the same height, requiring two to four mechanics to take about 15-20 minutes each to level them (per WCD instructions) before the aileron can be worked. The aileron must be level while skin work, hinge work, tab removal, or the leading edges are removed.

Felt is used for covering the table tops and particles of metal, etc. become embedded in the felt which further aggravates the problem of scratches. The table felt is difficult to clean even by using high pressure compressed air and requires about 15-20 minutes each shift to attempt to clean.

The tables permit access from only one side of the aileron and require the unit to be turned/rotated at least five times while being repaired. Some mechanics prefer to work on the aileron while it is in the flat position; consequently, the new jig will consider this flat attitude in the design. An engineering time/motion study will be conducted to determine the best positions for each primary repair operation as listed in the applicable WCD. The senior mechanics and their supervisors/alternates as well as the cognizant planners and tooling engineers, will be surveyed to get opinions and their manufacturing expertise regarding the new jig design and the human factors involved.

A focus study is recommended to provide a detailed analysis of the entire repair process technology but with the major effort directed toward the current tooling

(fixture/jigs, etc.) with a goal to develop a production increase of at least 30% and/or to decrease flow-time by a similar amount.

The present tooling is inefficient with a low (15%) utilization factor. An improvement in the tooling plan and concept would eliminate man-handling and be directed toward ending the flip-flopping that currently takes place.

Safety would be be improved tremendously with this improved tooling concept, which would eliminate the unsafe situations where the aileron could be dropped or possibly fall on someone, in addition to getting rid of the straining that occurs during handling.

The primary improvement in the tooling plan and concept will be to redesign and modify the existing check fixture to be able to rotate the aileron unit into the best workable position and lock it. Both sides of the aileron will be accessible; part-turning is practically eliminated, and consequently the repair effort will not be as tiring to the workers. Time and effort will be saved by making the present check fixture into a working jig where the aileron may be repaired most of the time while in the new jig. The aileron now is turned at least five times while being repaired.

The hinge location posts and supports as well as the attachment which locates the tapered shim on the front beam will most likely have to be made removable and be made part of a separate front beam modification tool.

The study will also include a new simple bar-type combination hinge locator and hinge line check fixture for the aileron. This type fixture could be brought to the aileron by the overhead crane/sling with far less effort than the present method of loading the aileron in the check fixture each time.

In addition to the design of the new working jig and the bar hinge locator tool, the study will also involve designing for wooden holding stands of customized shape and optimized size to be used in lieu of the flat top tables. These will support the aileron and eliminate the man-handling and flip-flopping from one

side to the other side. They will also allow both sides and the beam/tab areas to be worked simultaneously. These customized "cradles" will occupy less space than the currently used tables. They also have the advantage of allowing more protection to the skin surfaces than the aileron laying flat on the existing table surfaces.

10.4.4.2 Potential Cost Benefits

An annual recurring cost savings of $460,464 should occur from the implementation of the recommended improvements as shown in Table 10.4.4-2.

The investment cost of the recommendations is estimated at $1,140,230. This cost includes the focus study effort and the implementation cost.

The Cost Benefit Analysis (CBA) shows an Internal Rate of Return (IRR) of 26% and a savings of $534,874 in terms of Net Present Value (NPV) using constant FY 89 dollars, see Figure 10.4.4-1. The CBA is in compliance with regulation AFR173-15, cost analysis procedures, dated 4 March 1988 and rates per AFLCR 78-3.

The CBA covers the time frame starting with the focus study through five years after the completion of implementation. The recurring cost savings was assumed to start at the end of implementation.

The NPV takes into account the time value of money and is calculated by discounting a cash flow. The focus study cost, implementation cost, and the recurring savings were spread by fiscal year quarters and discounted back to the first quarter by using a mid-quarter discounting factor equivalent to an annual discount factor of 10%. Basically, this means a dollar that is earned in FY 90 is worth $.91 in FY 89 terms ($1.00/1.1), due to the ability to borrow or lend at a positive interest rate.

A sensitivity analysis was performed in which the investment cost varied between 50% and 200% of the estimated costs, see Figure 10.4.4-2.

SUMMARY OF INVESTMENT COST AND ANNUAL SAVINGS (CONSTANT FY89 DOLLARS)

TABLE 10.4.4-2 (SHEET 1 OF 2)

	CURRENT ANNUAL COSTS	PROPOSED CHANGE INVESTMENT COSTS	PROPOSED CHANGE ANNUAL COSTS
NONRECURRING COSTS (1)			
FOCUS STUDY	$0	$460,000 (2)	$0
FACILITIES			
LAND	$0	$0	$0
BUILDINGS	$0	$0	$0
SUPPORT EQUIPMENT			
DEVELOPMENT	$0	$0	$0
ACQUISITION	$0	$600,000 (3)	$0
INSTALL & CHECKOUT	$0	$60,000 (4)	$0
LOGISTICS SUPPORT			
INITIAL SPARES	$0	$0	$0
INITIAL TRAINING (DEV & PRESENTATION)	$0	$20,230 (5)	$0
TECHNICAL DATA	$0	$0	$0
TOTAL NONRECURRING COST	$0	$1,140,230	$0
RECURRING COSTS (1)			
TOUCH LABOR	$1,340,896 (6)	$0	$880,432 (7)
SUPPORT EQUIP MAINT	$0	$0	$0
SPARES AND SPARES MGMT	$0	$0	$0
TECHNICAL DATA	$0	$0	$0
MOD KITS	$0	$0	$0
CONFIGURATION DATA MGMT	$0	$0	$0
UTILITIES	$0	$0	$0
TOTAL RECURRING COSTS	$1,340,896	$0	$880,432
TOTAL COSTS	$1,340,896	$1,140,230	$880,432
ANNUAL COST SAVINGS	$460,464		

NUMBER OF MONTHS FOR FOCUS STUDY	6
NUMBER OF MONTHS TO IMPLEMENT CHANGES	12

SUMMARY OF INVESTMENT COST AND ANNUAL SAVINGS (CONSTANT FY89 DOLLARS)
TABLE 10.4.4-2 (SHEET 2 OF 2)

NOTES:

(1) ONLY ITEMS THAT ARE SIGNIFICANTLY AFFECTED BY THE PROPOSED CHANGE HAVE BEEN ESTIMATED

(2) ENGINEERING ESTIMATE FOR USE IN ENGINEERING TRADE STUDIES ONLY, DOES NOT REPRESENT FIRM PRICING

(3) NEW AND/OR IMPROVED AILERON TOOLING ESTIMATED COST OF $200K/NEW TOOL AND $100K/IMPROVED TOOL BASED ON CONVERSATIONS WITH RCC PERSONNEL REGARDING PREVIOUS TOOL MAKE AND PURCHASE COST :

($200,000 X 2) + ($100,000 X 2)

(4) ESTIMATED AT 10% OF SUPPORT EQUIPMENT ACQUISITION COST.

(5) TRAINING OF 16 MECHANICS:

16 X 40 HOURS X $31.61/HOUR

(6) BASED ON ACTUAL LABOR HOURS AND RATE:

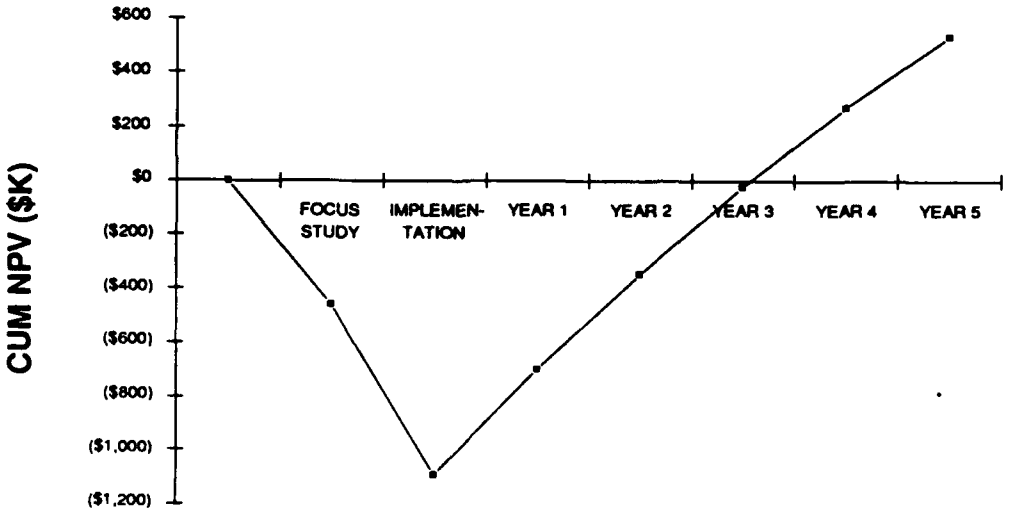
101 UNITS X 420 HOURS/UNIT X $31.61/HOUR.

(7) IMPROVEMENT OF 33% DUE TO IMPROVED EFFICIENCY AND GREATER UTILIZATION OF BOTH IMPROVED AND MODIFIED TOOLS/JIGS:

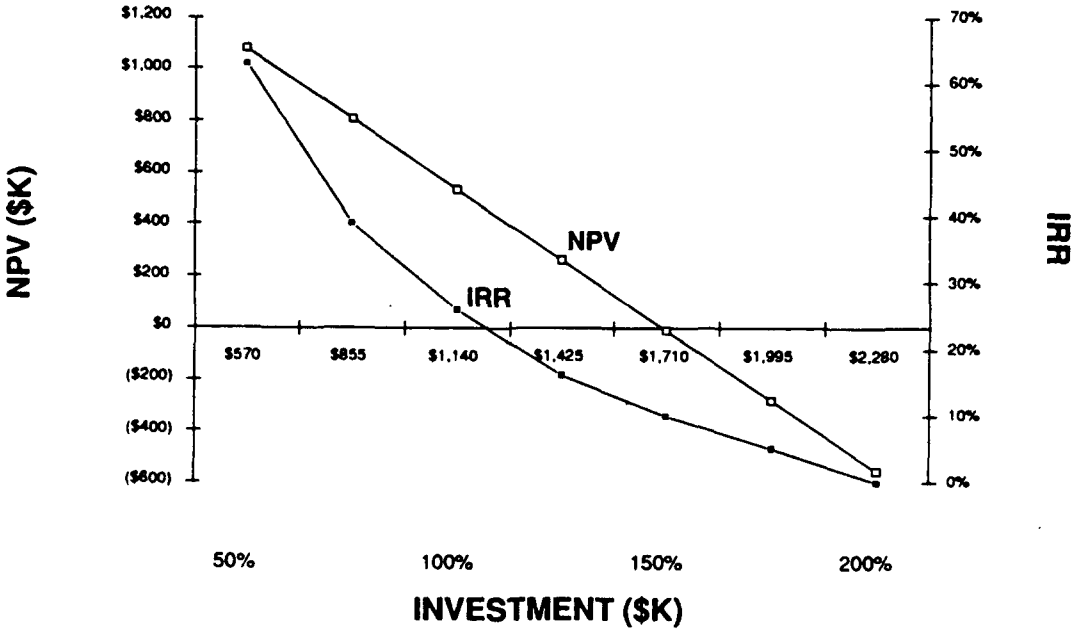
0.67 X 101 UNITS X 420 HOURS/UNIT X $31.61/HOUR.

(8) SAVINGS DUE TO IMPROVED QUALITY - FEWER REWORKS AND RETURNS - ASSUMES 2% SAVINGS:

0.2 X 0.67 X 101 UNITS X 420 HOURS/UNIT X $31.61/HOUR



CUM NPV IN CONSTANT FY89 DOLLARS
FIGURE 10.4.4-1



CBA SENSITIVITY ANALYSIS
FIGURE 10.4.4-2

10.4.4.3 Risk Assessment of Achieving Study Goals

The following is a list of the possible risks in achieving the study goals. MDMSC believes these risks are minimal.

- The actual cost savings can be quantified only after the detailed focus study is completed and the optimum recommendations selected for implementation.
- Some risks are inevitable because of the questionable historical data which established the As-Is condition of the current tooling situation.
- Implementation costs will involve some facility assessment and rearrangement and will not be considered in the focus study.

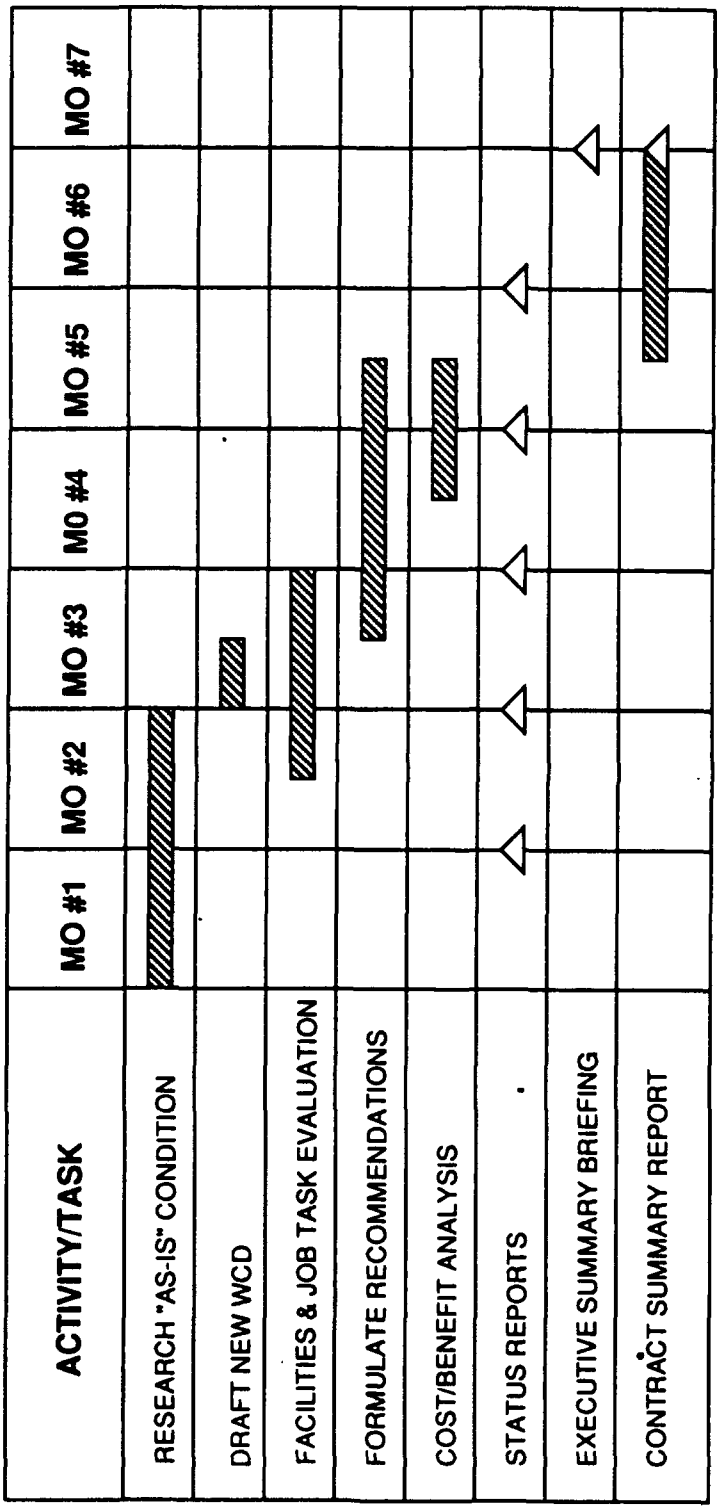
10.4.4.4 Duration and Level of Effort

MDMSC recommends a six-month-long focus study period of performance to:

- Research and establish the historical aspect of the As-Is condition of the C-141 aileron fixture/jig. Create a new WCD that will depict and represent the desired conditions expected out of the new tool plan.
- Assess all technical aspects, facilities and equipment along with performing the related job tasks appraisals necessary for increased tool usage and shorter flow time. The facilities may require expansion and the entire work plan will change.
- Include definite trade-offs, remedial facets of the overall situations, and the promotion of all the potentially positive aspects of the tooling problem.
- Summarize all cost-effective related manufacturing and tooling opportunities.

Figure 10.4.4-3 illustrates the proposed schedule to accomplish FSR No. 2.

It is estimated that a total of $460,000 is required to implement this recommendation. This number is an engineering ROM estimate for engineering trade studies only; it does not represent firm pricing.



LSC-20344

PROPOSED FSR NO. 2 SCHEDULE
FIGURE 10.4.4-3

10.4.5 Recommended Focus Study: RCC MANPSA/WR-ALC to Redesign and Modify the Existing C-141 Petal Door Working Jigs to Allow a Greater Part of the Repair Effort to be Accomplished in the Jig

This focus study will provide a detailed study and analysis of the C-141 petal door repair process technology currently being utilized in MANPSA. It will cover the entire range of effort currently described in the WCDs. In addition, the entire manufacturing and tooling situation including the scrapping and reworking of in-house and subcontractor parts will be studied. The alternate Lockheed composite petal doors and the associated lay-up fixtures will be examined and an engineering opinion will be included in the study.

Additionally the focus study will attempt to eliminate the excessive unsafe manhandling. The current outer/inner skin manufacturing problems will be reviewed along with proposed solutions and recommendations for current assembly problems and manufacturing recommendations for the alternate petal doors.

The petal door assembly jig design concept will be revised to allow a greater amount of work to be performed in the jig without having to remove the parts so often. At the present time the skin assemblies and the frame parts require removal and replacement approximately six times for each door rework. This could be reduced by adding a "Box-Jig" adaptation that would allow the skins to be placed back out of the way rather than removing the skins and the frame from the jig each-time. More jigs may be required for the current workload of petal doors, unless the work processes and jigs are made more efficient.

The economical feasibility of using holding fixtures for repaired assemblies will be examined and recommendations made. A holding fixture has the advantages of allowing work to be performed on each side of the unit at the same time and of giving more protection to the skin surfaces than if they were laid on table surfaces. The fixture will allow the work to be performed more easily because the assembly is more accessible and makes it less tiring to the workers.

Table 10.4.5-1 details the areas that will be affected by this focus study. Also shown is the MDMSC assessment of the level of effort required in the focus study to evaluate individual areas of analysis.

10.4.5.1 Rationale Leading to Change

There are some inconsistencies in the loft and dimensional data that were used for the petal door skins contour definitions and the currently used assembly fixtures at WR-ALC. Rohr Corporation made the inner/outer skin assemblies to a set of bonding tools that may not be contoured and shaped to the same set of master lines/dimensions as was used to define the contour locations on the currently used assembly fixture in Building 169 at WR-ALC. There should be a master set of data available from Lockheed that would define all the jigs, layup tools and other fixtures which could be used by WR-ALC and the sub-contractors to check and validate the contours. It is also believed that the layup tool that Lockheed used to build a composite petal door (left hand only) was made to a different set of loft and contour data. This tool is currently at WR-ALC. In fact, no master tool was available at any of the facilities of Rohr, WR-ALC or Lockheed. (Lockheed destroyed all C-141 tooling at the end of their contract run.)

It is thought that, if adequate space could be provided, the inner and outer skin assemblies could be made in-house at WR-ALC. If this is not feasible, an alternate manufacturer's source could possibly be Grumman Corporation, approximately 50 miles away in Milledgeville, Georgia.

The new inner skin and outer skin sub-contracted bonded assemblies for the petal door require inspection and repair work on the new assemblies before they are acceptable to be used. These new skins sometime have dents, scratches, voids, delaminations, etc. that require time and effort to fix before they can be used. Also, the potted location for the attachment fasteners require re-potting in the honeycomb skin area due to the locations not falling within the potted area. A cursory investigation showed that an increase in the potting area diameter from approximately one-half inch to one inch could possibly eliminate the problem of re-potting. WR-ALC is currently investigating the possibility of

PETAL DOOR FOCUS STUDY NO. 3 CRITERIA CHECKLIST

TABLE 10.4.5-1 (SHEET 1 OF 2)

AREA OF ANALYSIS	ACTIVITY (WHAT & HOW)	LEVEL OF EFFORT		
		MIN	AVG	MAX
Process/Material Flow	The sequence of repair operations will change. The focus study will determine and define the most effective flow of parts and process by in-depth research. Interviews will be conducted with all affected personnel.			X
Equipment/Work Place Layout	The new/modified jigs will impact the existing facilities layout and workstations. New work place layouts will be produced to maximize full utilization of all new/old equipment and work places.			X
Facility Requirements	Additional space will be required for new jigs, more so, if skins are made in-house. This will require a new facility. The focus study will ascertain optimum requirements in conjunction with LIFT modernization plans.			X
Labor Standards	The labor standards (WCDs) will require revisions to show best possible utilization of all pay labor grades in RCC MANPSA.			X
Manpower	Manpower will be reduced and/or better utilized. All workstations will be dedicated to the most efficient usage.			X
Task Assignments	Task assignments will require minor revisions which will be fully explored in the focus study to define maximum benefits.			X
Material Requirements	Inner/Outer skin manufacturing plan may require material changes due to the new focus study determinations.			X
Scrap Rates	There should be a major reduction in scrap/rework rates. The study will investigate those areas of rework for all parts and assemblies, including particular concentration on the inner/outer skin assemblies.			X

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PETAL DOOR FOCUS STUDY NO. 3 CRITERIA CHECKLIST

TABLE 10.4.5-1 (SHEET 2 OF 2)

AREA OF ANALYSIS	ACTIVITY (WHAT & HOW)	LEVEL OF EFFORT		
		MIN	AVG	MAX
Material Handling & Storage Methods	The petal doors will be manhandled/removed less often from the jig and will be handled by overhead crane. The entire handling and storage will be reviewed from uncrating to crating.			X
Inspection Techniques	The inspection operation will be improved and the unit being repaired will be made more inspectable due to the tool design/plan to provide better accessibility to perform all repair functions.			X
Equipment/Tools/Fixtures	The new tooling system will improve the mechanic's work efficiency and decrease process flow time and increase throughput. This is the main thrust of the study.			X
Process Delays	None expected.		X	
Part Identification	No changes anticipated.	X		
Quality	The reduced handling, better accessibility will improve quality of repair.		X	
Personnel Safety	The reduction of manhandling in lieu of overhead crane and sling will make for a safer operation.		X	
Environmental Assessments	No changes anticipated.	X		

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using denser honeycomb core to alleviate this problem. Most of the damage problems aforementioned are the fault of WR-ALC, but the voids, delaminations, or core damage are most likely the fault of the sub-contractor.

A cursory investigation has also discovered that these skin assemblies frequently are not made to the correct contour. An investigation should be made to ascertain how much time and money is being spent to rework these "new" inner skin and outer skin assemblies.

Another problem that has impacted the petal door repair cost is that the petal doors that arrive at WR-ALC to be inspected and repaired are consistently missing the strake.The strake is part of and should accompany the door. It is a large expense to WR-ALC when almost every C-141 petal door to come in for repairs with an expensive group of parts missing. A new strake has to be manufactured, all missing parts replaced, and the assembly strake shipped back out to stores.

Where are the missing strake parts? Who removes them from the petal door assembly? By what authority are they removed? Records show that some of these parts have a value of $20 to $30 each, and in many cases as many as twenty parts are missing. An investigation into this matter has been made, and an employee was given a cash award for bringing this matter to the attention of his managers. No resolution to the problem has been effected as of this date.

10.4.5.2 Potential Cost Benefits

An annual recurring cost savings of $286,080 occurs from the implementation of the recommended improvements as shown in Table 10.4.5-2. This cost assumes an increase of 50% from the FY 88 induction of 35 units, due to the elimination of current subcontractor problems. The primary goal of this focus study will be to get the petal door line into an optimized production capacity. The CBA used the standard hours of 502 for current hours. The investment cost of the recommendations is estimated at $1,140,230. This cost includes the focus study effort and the implementation cost.

SUMMARY OF INVESTMENT COST AND ANNUAL SAVINGS (CONSTANT FY89 DOLLARS)

TABLE 10.4.5-2 (SHEET 1 OF 2)

	CURRENT ANNUAL COSTS	PROPOSED CHANGE	
		INVESTMENT COSTS	ANNUAL COSTS
NONRECURRING COSTS (1)			
FOCUS STUDY	$0	$460,000 (2)	$0
FACILITIES			
LAND	$0	$0	$0
BUILDINGS	$0	$0	$0
SUPPORT EQUIPMENT			
DEVELOPMENT	$0	$0	$0
ACQUISITION	$0	$600,000 (3)	$0
INSTALL & CHECKOUT	$0	$60,000 (4)	$0
LOGISTICS SUPPORT			
INITIAL SPARES	$0	$0	$0
INITIAL TRAINING (DEV & PRESENTATION)	$0	$20,230 (5)	$0
TECHNICAL DATA	$0	$0	$0
TOTAL NONRECURRING COST	$0	$1,140,230	$0
RECURRING COSTS (1)			
TOUCH LABOR	$833,082 (6)	$0	$547,001 (7)
SUPPORT EQUIP MAINT	$0	$0	$0
SPARES AND SPARES MGMT	$0	$0	$0
TECHNICAL DATA	$0	$0	$0
MOD KITS	$0	$0	$0
CONFIGURATION DATA MGMT	$0	$0	$0
UTILITIES	$0	$0	$0
TOTAL RECURRING COSTS	$833,082	$0	$547,001
TOTAL COSTS	$833,082	$1,140,230	$547,001
ANNUAL COST SAVINGS	$286,080		

NUMBER OF MONTHS FOR FOCUS STUDY	6
NUMBER OF MONTHS TO IMPLEMENT CHANGES	12

SUMMARY OF INVESTMENT COST AND ANNUAL SAVINGS (CONSTANT FY89 DOLLARS)
TABLE 10.4.5-2 (SHEET 2 OF 2)

NOTES:

(1) ONLY ITEMS THAT ARE SIGNIFICANTLY AFFECTED BY THE PROPOSED CHANGE HAVE BEEN ESTIMATED

(2) ENGINEERING ESTIMATE FOR USE IN ENGINEERING TRADE STUDIES ONLY, DOES NOT REPRESENT FIRM PRICING

(3) NEW AND/OR IMPROVED PETAL DOOR TOOLING ESTIMATED COST OF $200K/NEW TOOL AND $100K/IMPROVED TOOL BASED ON CONVERSATIONS WITH RCC PERSONNEL REGARDING PREVIOUS TOOL MAKE AND PURCHASE COST:

($200,000 X 2) + ($100,000 X 2)

(4) ESTIMATED AT 10% OF SUPPORT EQUIPMENT ACQUISITION COST.

(5) TRAINING OF 16 MECHANICS::

16 X 40 HOURS X $31.61/HOUR

(6) BASED ON ACTUAL LABOR HOURS AND RATE:

35 UNITS X 502 HOURS/UNIT X $31.61/HOUR.

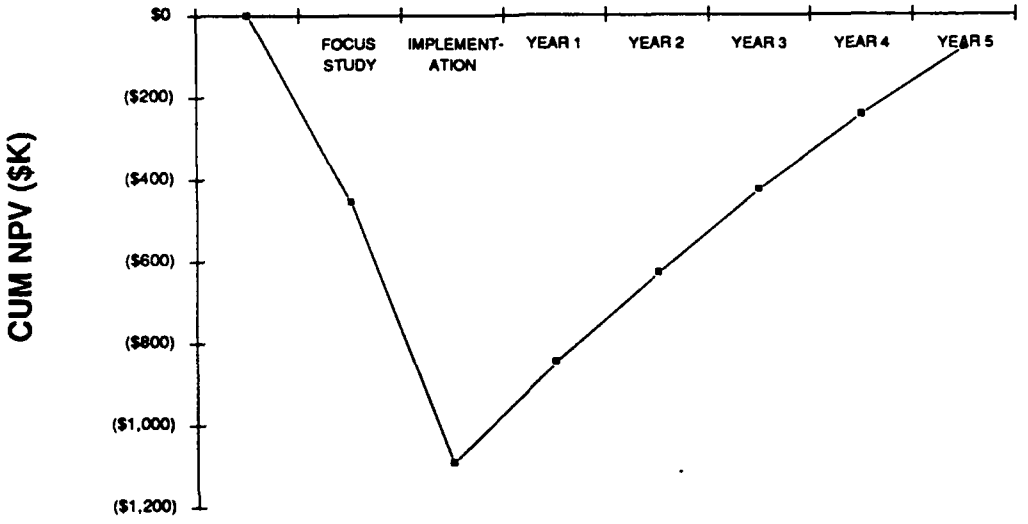
(7) IMPROVEMENT OF 33% DUE TO IMPROVED EFFICIENCY AND GREATER UTILIZATION OF BOTH IMPROVED AND MODIFIED TOOLS/JIGS:

0.67 X 35 UNITS X 502 HOURS/UNIT X $31.61/HOUR.

(8) SAVINGS DUE TO IMPROVED QUALITY - FEWER REWORKS AND RETURNS - ASSUMES 2% SAVINGS:

0.2 X 0.67 X 35 UNITS X 502 HOURS/UNIT X $31.61/HOUR

The Cost Benefit Analysis (CBA) shows an Internal Rate of Return (IRR) of 7% and a negative $80,791 in terms of Net Present Value (NPV) using constant FY 89 dollars, see Figure 10.4.5-1. The CBA is in compliance with regulation AFR173-15, cost analysis procedures, dated 4 March 1988 and rates per AFLCR 78-3.



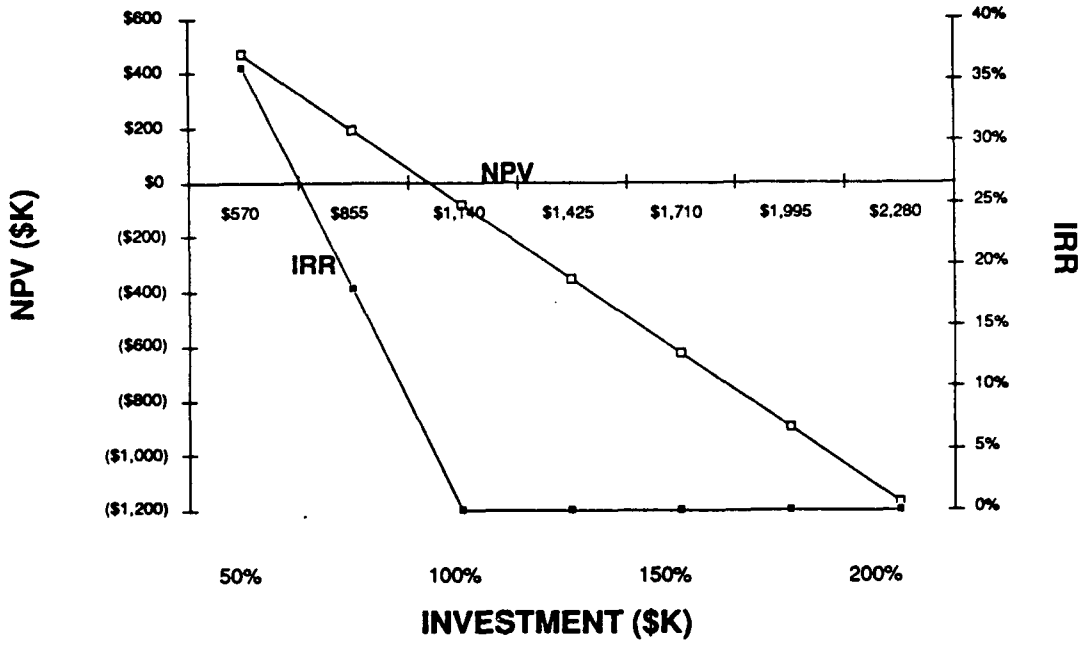
CUM NPV IN CONSTANT FY89 DOLLARS
FIGURE 10.4.5-1

The CBA covers the time frame starting with the focus study through five years after the completion of implementation. The recurring cost savings was assumed to start at the end of implementation.

The NPV takes into account the time value of money and is calculated by discounting a cash flow. The focus study cost, implementation cost, and the recurring savings were spread by fiscal year quarters and discounted back to the first quarter by using a mid-quarter discounting factor equivalent to an annual discount factor of 10%. Basically, this means a dollar that is earned in

FY 90 is worth $.91 in FY 89 terms ($1.00/1.1), due to the ability to borrow or lend at a positive interest rate.

A sensitivity analysis was performed in which the investment cost varied between 50% and 200% of the estimated costs, see Figure 10.4.5-2.



CBA SENSITIVITY ANALYSIS
FIGURE 10.4.5-2

10.4.5.3 Risk Assessment of Achieving Study Goals

The following is a list of the possible risks in achieving the study goals. MDMSC believes these risks are minimal.

- The actual cost savings can be quantified only after the detailed focus study is completed and the optimum recommendations selected for implementation.
- Some risks are inevitable associated with the historical research in establishing the As-Is condition of the current tooling situation.
- Implementation costs will involve some facility assessment and rearrangement and will not be considered in the focus study.

10.4.5.4 Duration and Level of Effort

MDMSC recommends a six month long focus study period of performance to:

- Research and establish the historical aspect of the As-Is condition of the C-141 petal door fixture/jig. Create a new WCD that will depict and represent the desired conditions expected out of the new tool plan.
- Assess all technical aspects, facilities and equipment along with performing the related job tasks appraisals necessary for increased tool usage and shorter flow time. The facilities may require expansion and the entire work plan will change.
- Include definite trade-offs, remedial facets of the overall situations and the promotion of all the potentially positive aspects of the tooling problem.
- Summarize all cost-effective related manufacturing and tooling opportunities.

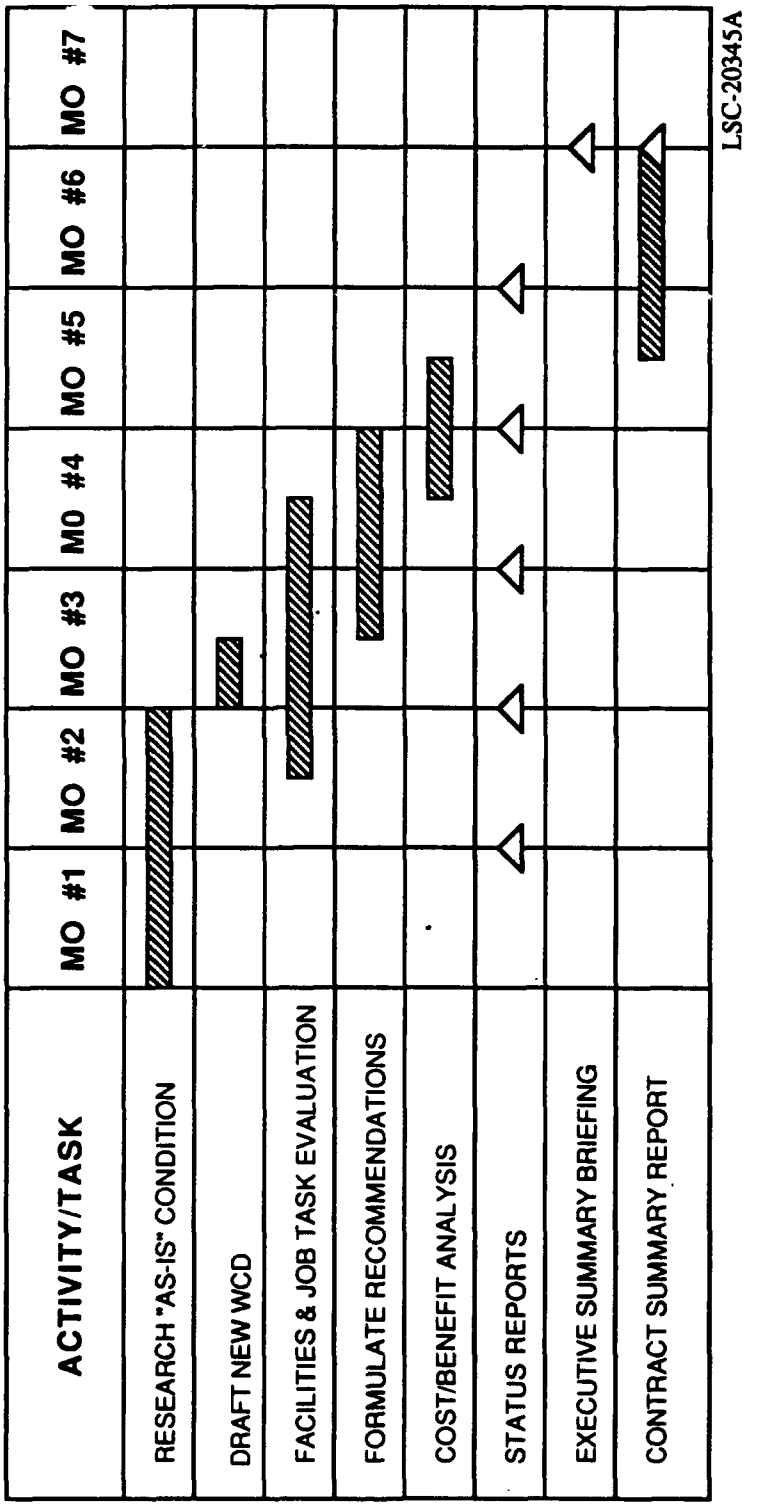
Figure 10.4.5-3 illustrates the proposed schedule to accomplish FSR No. 3.

It is estimated that a total of $460,000 is required to implement this recommendation. This number is an engineering ROM estimate for engineering trade studies only; it does not represent firm pricing.

10.4.6 Other Observations

The other observations described in this section were not considered as focus studies or quick fixes because they had a less significant impact on the areas of time, quality, or cost. These observations are recorded to assist WR-ALC in developing ideas that will further enhance their operations.

The observations which follow were originally identified as Quick Fix and Focus Study improvement opportunities and are detailed as such in the MANPSA Database Documentation Book. After review by the MDMSC/WR-ALC TI-ES team, it was mutually agreed that they should be presented as other observations for future reference.



PROPOSED FSR NO. 3 SCHEDULE

FIGURE 10.4.5-3

Environmental Improvement Opportunities

- Evaluate Cleanliness of Work Staging Area Near Autoclaves
  - Current Condition: Most layup is done in the Layup Room in Building 169 which is a controlled and compatible environment for the use of adhesives and bonding materials used in the manufacturing of MANPSA work. Some small patching and repair work is done in the teardown areas and in the staging area of the autoclave. There is not as much concern or attention given to bonding conditions and cleanliness in this area as there should be.
  - MDMSC Recommendation: A study should be conducted to determine if the conditions are unsatisfactory and if a plastic curtain dropped from the ceiling would help the situation. The sanding, drilling and working of metals/composites should be moved further away from the area where adhesive bonding is being done. The major benefit to isolating the bonding from the fabrication will be to create a somewhat controlled environment which is a requirement to the use of structural adhesives.
- Review Safety Precautions for Cleaning Solvent
  - Current Condition: Methyl Ethyl Ketone (MEK) is used as a cleaning solvent. MEK is a flammable material, and an irritant to workers.
  - MDMSC Recommendation: Another cleaning solvent may be used instead of the MEK. 1,1,1-Trichloroethane could be used as a replacement because it is nonflammable, thus less hazardous than MEK. This recommendation would need to be studied further to determine if this solvent would clean WR-ALC's parts to the standards. Other studies are currently being performed by AFLC to evaluate substitute solvents which are less hazardous than MEK or 1,1,1-trichloroethane, which may be substituted after further study.

- Review Safety Precautions for Uranium Counterbalance
  - Current Condition: There are inadequate warnings to the mechanics and handlers of the depleted uranium counterbalance weight used for the C-141 aileron. The Technical Order for the C-141 aileron lists the precautions to prevent exposure to radioactivity and the mechanics are aware of this hazard. There is no awareness of the "heavy metal" effects of ingesting ground depleted uranium powder. There should be no drilling or grinding of the depleted uranium counterbalance weight. This powder is toxic when ingested. A vinyl cover is available to address this problem, but it is not used effectively.
  - MDMSC Recommendation: Since it is feasible that the workers may accidentally grind on the uranium counterbalance during their work, the workers should be made aware of the toxic properties of this material. If grinding on the counterbalance is suspected, the work area should be tested by bioenvironmental engineering for uranium dust in the air. If concentrations are above OSHA standards, further training and protective equipment should be provided.

General Area Improvement Opportunities

- Use Lockheed "Status" to Determine Drawing Changes and Effectivity
  - Current Condition: There seems to be a bit of confusion at WR-ALC as to how to determine the effectivity of a part or of a drawing revision. This is especially pertinent to the drawings and parts for the Lockheed C-130 and C-141 aircraft. When the Air Force bought these airplanes from Lockheed, they also bought the drawings and the drawing submittal system, which would be in accordance with the applicable MIL specification for the drawing requirements.
  - MDMSC Recommendation: A phone call to "Status" at Lockheed could get an answer whenever a problem arises involving whether a C-130/C-141 part required on a particular model or not. "Status" could also be used to verify the latest drawing revision or Engineering Order change to a drawing.

- Obtain Better Quality/Delivery for the Petal Door Inner/Outer Skin Assemblies
  - Current Condition: The new inner skin and outer skin bonded assemblies for the petal door, which are made off site at a subcontractor, require inspection and repair work on the new assemblies before they are acceptable to be used. These new skins sometimes have dents, scratches, voids, delaminations, etc. that require time and effort to fix before they can be used as acceptable parts. Also, the potted location for the attachment fasteners require repotting in the honeycomb skin area due to the locations not falling within the potted area. Most of the damage is the fault of WR-ALC but the voids, delaminations, or core damage are most likely the fault of the subcontractor.
  - MDMSC Recommendation: An investigation team should be formed to ascertain how much time and money is being spent to rework these new inner skin and outer skin assemblies and visit the new subcontractor, if necessary. A cursory investigation has also discovered that these skin assemblies frequently are not made to the correct contour. After reviewing the bonding capabilities and the autoclave facilities MDMSC has concluded that both of these skin assemblies could be made at WR-ALC. Redesign the petal door assembly jig to allow a greater amount of work to be performed in the jig without having to remove the parts so often. At the present time, the skin assemblies and the frame parts require removal and replacement approximately six times for each door. This could be reduced by adding a box jig adaptation that would allow the skins to be placed back out of the way rather than removing the skins and the frame from the jig each time. More jigs are required for the current workload of petal doors.

Operational Improvement Opportunities

- Review/Allocate Sufficient/Dedicated Work Space for Each Workstation
  - Current Condition: There is much confusion now in certain areas because of the lack of dedicated and sufficient space for the mechanics to perform their work. Traffic cross flow is bad and in some instances there is no assigned or dedicated work space for the mechanic to perform the task. Observation of several areas in Building 169, such as the areas for the petal doors and ailerons for the C-141, led to this conclusion.
  - MDMSC Recommendation: The work space for a given repair task must be adequate to allow the work to be performed in the most timely and cost effective manner. Each work station must be designed and space allotted to allow the mechanic to perform the assigned task without interruption from people passing by, cross flow traffic from fellow workers, insufficient space and confusion. MDMSC recommends, as a stop gap measure before an in-depth facilities layout can be made, that each work station be identified and permanently marked so that the mechanics assigned to that work station may work with a minimum of interruptions. Rails or fences should be considered to outline the stations.

Management Improvement Opportunities

- Put More Emphasis on QP4
  - Current Condition: Some RCC repair units do not have an active QP4 team. Those that do are not allotted the necessary time to be effective. Manpower seems to be a problem.
  - MDMSC Recommendation: Long standing complicated problems have a greater chance of being solved when a QP4 team is active in the area. More emphasis should be placed on the QP4 team effort and these groups should be given greater visibility and recognition as problem solvers. The QP4 teams are currently being revised and restructured. It is suggested that more recognition and prestige be given the group.

- Include the Supervisor When Decisions are Made Affecting Quality/Production
  - Current Condition: Decisions are sometimes made that affect the production effort or the quality of a repair unit without the supervisor being told or asked to participate in the decision making process.
  - MDMSC Recommendation: Better solutions to MANPS problems may be realized if when a task force is formed, it is formed from individuals most knowledgeable and intimately concerned with a solution to the problem, such as the production supervisor if the problem involves the production effort; or the tooling expert if the problem involves a tool change; or the planner if any change is contemplated in the work sequence or planning. The task force should always be headed up by the production supervisor if the problem involves production or quality.
- Eliminate Missing Petal Door Strake Parts (W. Pittman's Investigation)
  - Current Condition: The petal doors that arrive at WR-ALC to be inspected and repaired are consistently missing the strake which should accompany the door. This is an expensive group of parts. It is a major expense to WR-ALC when a new strake has to be manufactured and shipped back out to stores for almost every C-141 petal door that comes in for repairs.
  - MDMSC Recommendation: An investigation into this matter has been made and an employee was given a cash award for bringing this matter to the attention of his managers but no resolution to the problem has been effected as of this date.

Process Capability Opportunities

- Utilize the Planning Section for Help for All Manufacturing Coordination
  - Current Condition: When the manufacturing people (mechanics) have problems pertaining to the engineering and other data requirements for a particular unit being repaired, they usually directly contact the technical support people, such as the manufacturing, tooling, facilities, or materials engineer. Usually the mechanics are not as well versed as the planner as to the overall part requirement and design intent and consequently should take the problem through the planner for him to make the contact.
  - MDMSC Recommendation: Make better use of the planning section to help solve all problems involving the technical implementation of the Work Control Document (WCD). When the planner is contacted, he will be in a better position to: 1) Assist the mechanic to prevent work stoppages, 2) Revise the WCD, when required, 3) Coordinate the production effort, 4) Influence the standard hour requirement, and 5) Help solve tooling problems and requirements.
- Utilize the Quality Section for Help for All Repair Problems Involving Quality
  - Current Condition: The supervisors and their designees often do not call the quality assurance specialist to help solve problems arising from the repair effort.
  - MDMSC Recommendation: The quality assurance specialist should be utilized by issuing a Request for Quality Assistance (RQA) (AFLC Form 354). The quality assurance specialist will use the skills and facilities available to develop valid solutions or recommendations on all RQAs. Examples include: Quality Engineering, Methods Improvement Laboratory, Chemical or Materials Laboratories, and subject matter specialists from other divisions or directorates. All corrective actions will be thoroughly coordinated with all activities having a primary or collateral responsibility. Time will be reduced and/or work efficiency will be increased and as a result, the production rate increased.

10.5 MANPSB ANALYSIS AND FOCUS STUDY RECOMMENDATIONS

MANPSB is a unique manufacturing RCC under the MANPS section of the Industrial Products Division (MAN) at WR-ALC. This RCC has two sheet metal sections, a tubing and cable section, a template and block section, and a workshop. This RCC is dispersed throughout Building 169 due to the nature of the work and equipment.

The two sheet metal manufacturing sections are located next to each other. The workload is based on new parts that are required for repair by other RCCs and fluctuates considerably due to the diversified repair workload. At this time, more new parts are manufactured to support the F-15 repair than for the C-130 and C-141 repair effort.

All of the workload consists of parts to be manufactured per temporary request. The volume of parts varies considerably and historically the volume of workload has been high; presently, the workload has declined and is on the low side.

During initial characterization of the MANPSB RCC, a total of 12 potential improvement opportunities were identified (reference MANPSB Database Documentation Book, Potential Improvement Opportunities section). After review of this original set of opportunities by the MDMSC/Air Force team, four improvement opportunities were selected to be pursued as the focus of the TI-ES Program activities relating to MANPSB.

None of the improvement opportunities were selected to be presented as focus studies for MANPSB.

The four quick fixes applicable to RCC MANPSB are summarized below.

- Develop a Mechanic's Handbook for Each Repaired Assembly
  Proposed to compliment and supplement the Technical Orders and document all major steps and techniques of each repaired assembly unit. The manual would be invaluable to new or less experienced mechanics in a rapid build-up surge or war-time readiness situation or where a production rate increase would be necessary such as the present F-15 wing repair effort.

- Implement Program for the Mechanic to Buy and Maintain Own Handtools
  Proposed to eliminate/reduce the number of tools/boxes/stands, tool crib manpower and purchasing expense. The plan will provide the necessary tools and make the worker responsible for the tool inventory and the replacement of broken handtools.

- Provide Pictorial Drawings With the Existing Workbooks(WCDs)
  Proposed to assist the worker to better understand the required task and to help train others in a surge or war-time emergency situation.

- Make Available Cobalt-Tipped Drill Bits, or Equivalent
  Proposed in lieu of resharpened drill bits, for the mechanic's use to drill out aluminum rivets and other type fasteners such as steel bolts and blind steel rivets.

These quick fixes offer benefits to MANPSB in terms of quality, time, and cost, and then are described in detail under separate cover (reference Technology Insertion-Engineering Services Process Characterization, Task Order No. 1, Volume VII Quick Fix Plan WR-ALC, MANPSB Quick Fix opportunities section).

The remainder of the original MANPSB improvement opportunities are presented as other observations and are described in paragraph 10.5.4 of this document.

10.5.1 Description of Current Operations

RCC MANPSB of WR-ALC is basically a sheet metal manufacturing shop. This RCC has presses from the 250 ton Erie to an 80-ton press. It also has varieties of band saws, a turret punch, and metal shears. The list of special machines include a Wiedematic, a numerical controlled tube bender, a stretch press, a hydroform, a metal router , and a Murdock hot form press. This RCC is also complimented with a standard drill press, punch press equipment, tube benders, and work tables with a pneumatic air drops. Generally, utilization of equipment is low.

Table 10.5.1-1 depicts the part control numbers involved in the 80/20 analysis of the FY 88 workload for RCC MANPSB. Figure 10.5.1-1 is a general sheet metal process flow chart for RCC MANPSB.

The age of equipment falls into two ranges: one being 15 years and older and the other five to eight years old.

The facility layout drawing of RCC MANPSB does represent the As-Is condition. However, the facility layout is not efficient. At this time the equipment was grouped by category not by the flow of process. WR-ALC should layout this MANPSB shop with basic key N/C machines and special machines and operate like a private job shopper.

The RCC supervisor's portable office faces the main aisle and he cannot view his work force.

MANPSB has a unit chief who reports to the section chief of the sheet metal shop. The unit chief has four supervisors: two for sheet metal, one for tube shop, and one for the tool and die shop. This unit gets good support from the planning and scheduling groups.

RCC MANPSB's work force fluctuates with workload. The work force is comprised of sheet metal mechanics, pattern and form makers, two supervisors, a unit chief, and a clerk.

MANPSB MFG. SHEET METAL SHOP FY 88 WORKLOAD

TABLE 10.5.1-1

PART CONTROL NUMBER (PCN)	FY 88 INDUCTIONS				TOTALS
	1ST QTR	2ND QTR	3RD QTR	4TH QTR	
M0218K	100	110	110	100	420
M0219K	100	110	110	100	420
M0220K	100	110	110	100	420
M0221K	100	110	110	100	420
M0229K	100	110	110	100	420
M1495K	65	65	63	63	256
M1864K	700	780	726	736	2942
M1866K	700	780	726	736	2942
M3651K	200	300	291	290	1081
M3685K	200	300	291	290	1081
M4764K	15	15	14	14	58
M5243K	200	300	303	268	1071
M5351K	200	300	291	290	1081
M5743K	200	300	303	268	1071
M9929K	200	300	303	268	1071

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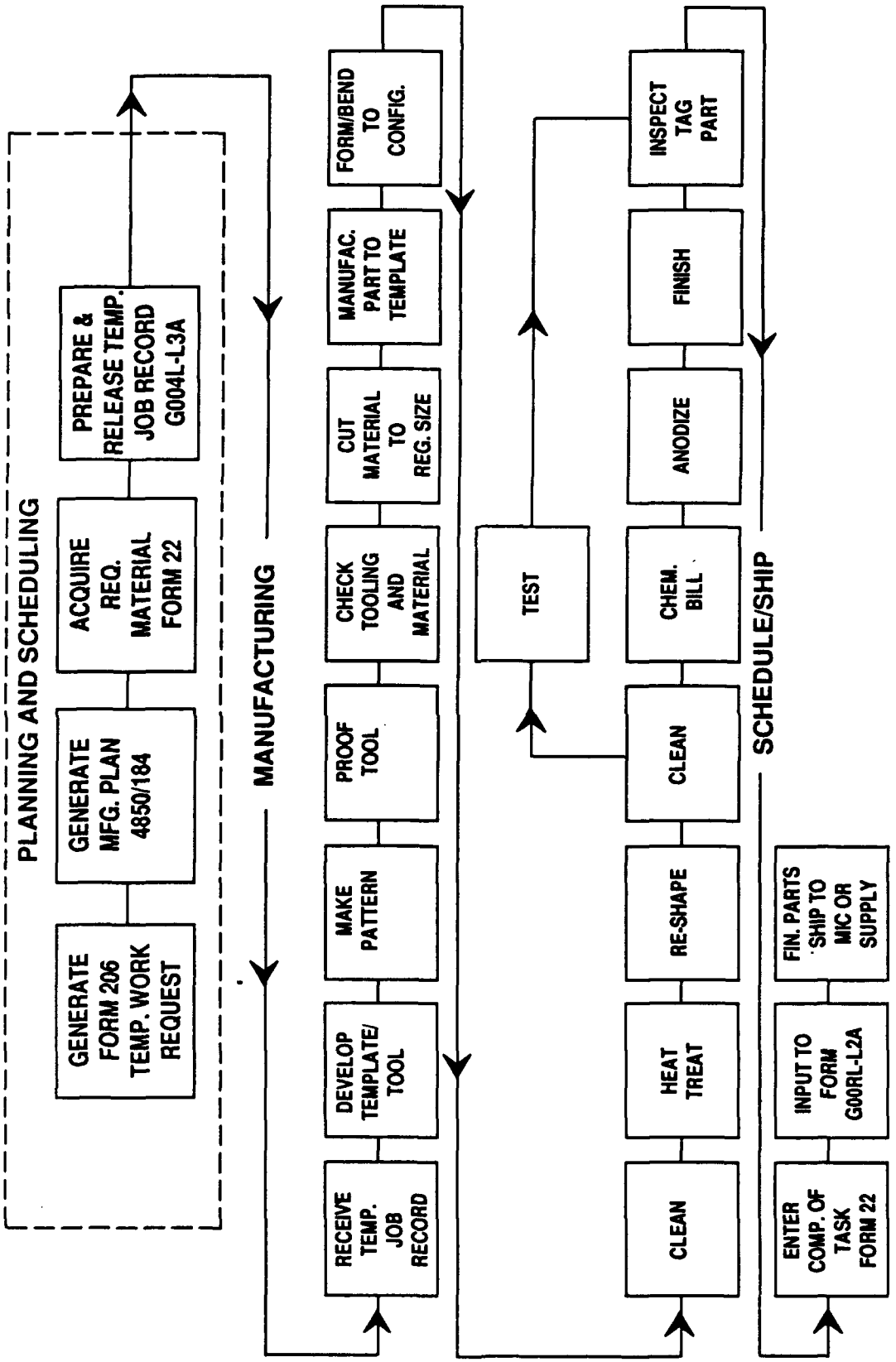

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MANPSB MFG SHEET METAL PROCESS FLOW CHART
FIGURE 10.5.1-1

The following is a breakdown of manpower within MANPSB:

Skill Code	Skill Level	Quantity	Position Description
46001	WG-11	5	Sheet metal mechanic (Aircraft)
46005	WG-08	24	Sheet metal worker
48107	WG-12	3	Pattern maker
48687	WG-10	3	Form block maker
50359	WG-10	30	Sheet metal mechanic
50889	WG-05	4	Sheet metal mechanic helper
9M075	WG-03	2	Worker trainee

It is to be noted that the work force defined here was as of the 4th quarter, 1988.

The manufacturing process within MANPSB consists of four or five major operations. Most of the parts will be processed as detailed below:

- Cut to size
- Bend/form to shape
- Clean
- Heat treat
- Test
- Finish
- Inspect and Ship

Material will be one of the following three; aluminum, titanium, or stainless steel.

Material handling equipment consists of a standard forklift and dollies. This is one of the areas which needs much improvement.

Templates and form blocks are stored in Building 161. Dies are stored next to a machine based on their usage. End items are shipped at the completion of task so there is no storage required except for work in progress.

10.5.2 Statistical System Performance Measures

MANPSB is a sheet metal manufacturing RCC with capability to fabricate parts required to repair C-141, C-130 and F-15 aircraft. The WR-ALC/MDMSC TI-ES team selected fifteen PCNs to represent a generic family of parts produced in this RCC. These PCNs were selected based on the typical process and the equipment required to manufacture the parts. The team's process characterization of these PCNs included gathering data via:

- Interview with ALC/RCC personnel
- Historical information with scheduling personnel assistance
- Maintenance and production interviews concerning equipment MTBF and MTTR

The profile data sheet information was then transferred to personal computer files using a Lotus 1-2-3 database storage system. After data verification, flat files for this RCC were generated. Simulation runs were then executed utilizing UDOS 2.0.

The WR-ALC/MDMSC TI-ES team, along with an AFLC representative, approached this unique RCC differently in validating the model. As detailed earlier, PCNs from this RCC do not have adequate historical data, WCD, or standards. The simulation model was validated by comparing the throughput of FY 88 and by the confidence gained by the team in validating six other RCCs from this ALC. The results are discussed in detail in section 6.0 of the DDB for MANPSB. The statistics then generated by the simulation model were within an acceptable range when compared to the As-Is condition. This simulation model database represents the As-Is condition for FY 88 and is a baseline for comparison purposes.

Brainstorming was performed during the model validation of RCC MANPSB. Representatives from production, scheduling, planning, quality and industrial engineering from WR-ALC and MDMSC participated in this session. Suggestions to reduce flow time and increase throughput were discussed and points noted. A "fishbone" (cause and effect) diagram was developed from these suggestions and is graphically depicted in section 9.0 of MANPSB's DDB.

The WR-ALC/MDMSC TI-ES team analyzed the output of the model to determine the appropriate control factors in meeting the outcome of brainstorming sessions. The team agreed to use the following assumptions and control factors to view the trend on throughput.

- Workload for MANPSB will be 130% of FY 88 workload.
- No change to manpower quantity.
- Categorized the factor for equipment as Base, Base+ and Base++ without making any major change. Deleted equipment 0795 from Base+ condition because it had 0% utilization. This was assumed to view the trend of manpower utilization.

The L_9 Taguchi array was constructed based on the above assumptions and factors and is depicted in Table 10.5.2-1. The table shows the overall throughput percentages for the PCNs that were profiled. The table also lists the individual PCNs which showed the best and worst throughput percentage under each experimental run.

Results of all the experimental runs indicate that the throughput of RCC MANPSB are all around 98%. Considering the high quantity of inductions and statistical variation, this RCC has capability to produce 100% throughput during peace time as well as surge time. This RCC does have more equipment than required to support surge time. Evaluation of best and worst PCNs reveals almost the same results except one run, where PCN M5743K is waiting for resources to do the setup operation.

To evaluate the RCC MANPSB capability to respond to surge condition, the following assumptions were agreed to by WR-ALC/MDMSC team.

- Same manpower as in FY 88.
- Spread the manpower between two 12-hour shifts - five days a week.
- Increase the FY 88 workload by surge factors provided by AFLC for weapon systems serviced by WR-ALC.

MANPSB SHEET METAL SHOP TAGUCHI ORTHOGONAL ARRAY

TABLE 10.5.2-1

RUN #	FACTORS & LEVELS						WORKLOAD (THROUGHPUT)		
	MANPOWER			OVERTIME		EQUIPMENT	INDUCTIONS: 19,178: 130% OF FY 88		
	1	2	3	SAT	SUN		AVG.	BEST	WORST
1	ALL					BASE	92.5 %	M0218K 100.3 %	M5743K 49.0 %
2	ALL			YES	YES	BASE +	98.5 %	M0218K 102.0 %	M9929K 98.0 %
3	ALL			YES	YES	BASE ++	98.8 %	M0218K 101.0 %	M9929K 98.0 %
4	50%	50%				BASE ++	98.7 %	M0218K 100.3 %	M9929K 97.5 %
5	50%	50%		YES	YES	BASE	98.9 %	M0218K 100.0 %	M5243K 98.0 %
6	50%	50%		YES	YES	BASE +	98.5 %	M0218K 100.1 %	M9929K 96.0 %
7	1/3	1/3	1/3			BASE +	98.0 %	M0218K 101.0 %	M5243K 98.0 %
8	1/3	1/3	1/3	YES	YES	BASE ++	98.9 %	M0218K 101.0 %	M9929K 98.0 %
9	1/3	1/3	1/3	YES	YES	BASE	99.0 %	M0218K 101.0 %	M9929K 98.0 %
SURGE*	50%**	50%**				BASE	97.0 %	M0218K 100.0 %	M9929K 93.0 %

NOTES:
* INDUCTIONS = 10,080 (2 QTRS)
** TWO 12 HOUR SHIFTS.

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An experimentation run was executed with above assumptions for two quarters. The average throughput analysis indicates that RCC MANPSB has the capability to meet surge condition.

10.5.3 Description of Process Problems

The intent of this paragraph is to expound on major process problems for which there are focus study recommendations. Since there were no major process problems identified for RCC MANPSB at this time, improvement opportunities addressed in this section are identified as other observations in this report or quick fixes in the Quick Fix Plan.

10.5.4 Other Observations

The other observations described in this section were not considered as focus studies or quick fixes because they had a less significant impact on the areas of time, quality, or cost. These observations are recorded to assist WR-ALC in developing ideas that will further enhance their operations.

The observations which follow were originally identified as Quick Fix and Focus Study improvement opportunities and are detailed as such in the MANPSB DDB. After review by the MDMSC/WR-ALC TI-ES team, it was mutually agreed that they should be presented as other observations for future reference.

Environmental Improvement Opportunities

- Review Safety Precautions for Cleaning Solvent
  - Current Condition: Methyl Ethyl Ketone (MEK) is used as a cleaning solvent. MEK is a flammable material and an irritant to workers.
  - MDMSC Recommendation: Another cleaning solvent may be used instead of the MEK. 1,1,1-trichloroethane could be used as a replacement because it is nonflammable, thus less hazardous than MEK. This recommendation would need to be studied further to determine if this solvent would clean WR-ALC's parts to the standards. Other studies are currently being performed by AFLC to evaluate substitute solvents which are less hazardous than MEK or 1,1,1-trichloroethane, which may be substituted after further study.

Process Capability Opportunities

- Utilize the Planning Section for Help for All Manufacturing Coordination
  - Current Condition: When the manufacturing people (mechanics) have problems pertaining to the engineering and other data requirements for a particular unit being repaired, they usually directly contact the technical support people, such as the manufacturing, tooling, facilities, or materials engineer in a direct contact manner. Usually the mechanics are not as well versed as the planner as to the overall part requirement and design intent and consequently should take the problem through the planner for him to make the contact.
  - MDMSC Recommendation: Make better use of the planning section to help solve all problems involving the technical implementation of the WCD. When the planner is contacted, he will be in a better position to: 1) assist the mechanic to prevent work stoppages, 2) revise the WCD, when required, 3) coordinate the production effort, 4) influence the standard hour requirement, and 5) help solve tooling problems and requirements.
- Utilize the Quality Section for Help for All Repair Problems Involving Quality
  - Current Condition: The supervisors and their designees often do not call the quality assurance specialist to help solve problems arising from the repair effort.
  - MDMSC Recommendation: The quality assurance specialist should be utilized by issuing a Request for Quality Assistance (RQA) (AFLC Form 354). The quality assurance specialist will use the skills and facilities available to develop valid solutions or recommendations on all RQAs. Examples include, Quality Engineering, Methods Improvement Laboratory, Chemical or Materials Laboratories, and subject matter specialists from other divisions or directorates. All corrective actions will be thoroughly coordinated with all activities having a primary or collateral responsibility. Time will be reduced and/or work efficiency will be increased and as a result, the production rate increased.

General Area Improvement Opportunities

- Provide Heavy Cardboard Reusable Shipping Boxes
  - Current Condition: Parts are currently being moved from one area to another by hand carrying or by laying them loose on a rolling hand cart while they are being transported.
  - MDMSC Recommendation: Heavy cardboard, reusable boxes should be used to protect the smaller parts when they are transported from one area or back shop to another area. These are sometimes called "banana boxes" because they are about the same shape and construction as the boxes used to ship bananas. These boxes would be similar to the ones used in the tubing/cable shop to contain and transport parts. Using these boxes with styrofoam and/or "bubble wrap" will minimize damage to parts being transported.
- Use Lockheed "Status" to Determine Drawing Changes and Effectivity
  - Current Condition: There seems to be a bit of confusion at WR-ALC as to how to determine the effectivity of a part or of a drawing revision. This is especially pertinent to the drawings and parts for the Lockheed C-130 and C-141 aircraft. When the Air Force bought these airplanes from Lockheed, they also bought the drawings and the drawing submittal system, which would be in accordance with the applicable MIL specification for the drawing requirements.
  - MDMSC Recommendation: A phone call to "Status" at Lockheed each time could get an answer whenever a problem arises involving whether a C-130/C-141 part is required on a particular model or not. "Status" could also be used to verify the latest drawing revision or Engineering Order change to a drawing.

Operational Improvement Opportunities

- Review/Allocate Sufficient/Dedicated Work Space for Each Workstation
  - Current Condition: There is much confusion now in certain areas because of the lack of dedicated and sufficient space for the mechanic and the work to be performed. Traffic cross flow is bad and in some instances, there is no assigned or dedicated work space for the mechanic to perform the task. Observation of several areas in Building 169, such as the areas for the petal doors and ailerons for the C-141, led to this conclusion.
  - MDMSC Recommendation: The work space for a given repair task must be adequate to allow the work to be performed in the most timely and cost effective manner. Each work station must be designed and space allotted to allow the mechanic to perform the assigned task without interruption from people passing by, cross flow traffic from fellow workers, insufficient space and confusion. MDMSC recommends, as a stop gap measure before an in-depth facilities layout can be made, that each work station be identified and permanently marked so that the mechanics assigned to that work station may work with a minimum of interruptions. Rails or fences should be considered to outline the stations.

Management Improvement Opportunities

- Put More Emphasis on QP4
  - Current Condition: Some RCC repair units do not have an active QP4 team. Those that do are not allotted the necessary time to be effective. Manpower seems to be a problem.
  - MDMSC Recommendation: Long standing complicated problems have a greater chance of being solved when a QP4 team is active in the area. More emphasis should be placed on the QP4 team effort and to give these groups greater visibility and recognition as problem solvers. The QP4 teams are currently being revised and restructured. It is suggested that more recognition and prestige be given the group.

- Include the Supervisor When Decisions are Made Affecting Quality/Production
  - Current Condition: Decisions are made sometimes that affect the production effort or the quality of a repair unit without the supervisor being told or asked to participate in the decision making process.
  - MDMSC Recommendation: Better solutions to MANPS problems may be realized so that when a task force is formed, it is formed from individuals most knowledgeable and intimately concerned with a solution to the problem, such as the production supervisor if the problem involves the production effort; or the tooling expert if the problem involves a tool change; or the planner if any change is contemplated in the work sequence or planning. The task force should always be headed up by the production supervisor if the problem involves production or quality.

10.6 MANPSC ANALYSIS AND FOCUS STUDY RECOMMENDATIONS

MANPSC is an RCC within the MANPS section of the Industrial Products Division (MAN) at WR-ALC. MANPSC is located in Building 169.

The workload within MANPSC is entirely MISTR work, consisting of some adhesive bonding work and conventional sheet metal work. This includes the C-141 Aft Cowling, the C-141 Thrust Door, the C-130 Cowl Scoop, the C-130 Elevator, and the C-130 Flaps.

During initial characterization of the MANPSC RCC, a total of 12 improvement opportunities were identified (reference MANPSC Database Documentation Book, Potential Improvement Opportunities section). After review of this original set of opportunities by the MDMSC/Air Force team, five improvement opportunities were selected to be pursued as the focus of the TI-ES Program activities relating to MANPSC.

One of the improvement opportunities is a focus study identified as the Redesign and Modification of Existing C-141 Aft Cowl Jigs. This focus study proposes modifying the existing jigs and adding newly designed jigs to enable most of the work to be accomplished in jigs, rather than on tables. This Focus Study is presented in paragraphs 10.6.4 through 10.6.4.4.

Also, the focus study identified as the C-141 Aileron, Petal Door, and Aft Cowl Tooling, detailed in paragraph 10.6.5, proposes combining FSR No. 2, FSR No. 3, and FSR No. 4 as the most cost effective way to rework/modify existing tools and additional jigs to boost throughput to the desired level.

The four quick fixes applicable to RCC MANPSC are summarized below.

- Develop a Mechanic's Handbook for Each Repaired Assembly. Recommended to compliment and supplement the Technical Orders and document all major steps and techniques of each repaired assembly unit. The manual would be invaluable to new or less experienced mechanics in a rapid build-up surge or war-time readiness situation or where a production rate increase would be necessary such as the present F-15 wing repair effort.

- Implement Program for the Mechanic to Buy and Maintain Own Hand Tools. Recommended to eliminate/reduce the number of tools/boxes/stands, tool crib manpower and purchasing expense. The plan will provide the necessary tools and make the worker responsible for the tool inventory and the replacement of broken hand tools.

- Provide Pictorial Drawings With the Existing Workbooks(WCDs). Recommended to assist the worker to better understand the required task and to help train others in a surge or war-time emergency situation.

These quick fixes offer benefits to MANPSC in terms of quality, time, and cost and are described in detail under separate cover (reference Technology Insertion-Engineering Services Process Characterization, Task Order No. 1, Volume VII Quick Fix Plan WR-ALC, MANPSC Quick Fix opportunities section).

The remainder of the original MANPSC improvement opportunities are presented as other observations and are described in paragraph 10.6.6 of this document.

10.6.1 Description of Current Operations

MANPSC is comprised mainly of conventional sheet metal and certain specialized composite material fabrication equipment. MANPSC has large assembly and check fixtures, rivet installation holding fixtures, fixed tables and dollies, overhead lifting cranes, transport dollies, drying ovens, autoclaves, equipment for autoclave support, and other ordinary support equipment.

MANPSC also has the normal sheet metal equipment to support the MISTR workload, such as hand brakes, hand formers, a drill press, a band saw, a hole punch, a bench grinder, as well as all the rivet driving and upsetting tools necessary to support the numerous type of fasteners used in repair/overhaul work.

Most of the equipment within MANPSC is between ten and 20 years old, with some 40 or more years. The equipment is mostly in good working and usable condition. New, replacement pieces of equipment are planned for purchase within the next ten years. A listing of all equipment for MANPSC can be found in the Equipment Profile List of Section 5.0 of the DDB.

MANPSC is headed by a unit chief with five supervisors. The unit chief reports to a section chief. The supervisors are knowledgeable of the end items and the repair processes.

MANPSC has a less than adequate work force. Other RCC areas such as the F-15 Wing Repair has priority over the MANPSC work and has drawn a few people from the MANPSC effort. The remaining work force is well trained and well supervised. Personal interviews and the interviewees' attendance at several "QP 4" meetings has indicated a sense of professionalism and pride among the work force.

This work force is comprised mainly of aircraft sheet metal mechanics of three basic classifications: metal bond, autoclave, and the general sheet metal type. There are two foreman classifications, one leader in training, a secretary, a tool and parts attendant, and a worker trainee.

The following constitutes a listing of the available manpower within MANPSC.

Skill Code	Skill Level	Quantity	Experience
48127	WS-14	2	20
47886	WS-10	2	15
9A014	WS-10	38	12
9A012	WS-08	50	10
10860	WS-05	5	5
9A075	GS-05	2	3
48913	GS-03	1	1

MANPSC is supported by good planning and scheduling departments. The Material Inventory Control (MIC) and the tool crib work closely with the supervisors to meet their needs and requirements.

The repair process technologies within MANPSC consist of major unit manufacturing and small sheet metal work. This includes conventional, honeycomb bonded, and composite repairs on high value C-141 and C-130 major aircraft assemblies. These assemblies are critical to flight safety and the performance of the aircraft in their assigned mission. Table 10.6.1-1 depicts the part control numbers involved in the 80/20 analysis of the FY 88 workload for RCC MANPSC.

MANPSC SHEET METAL SHOP FY 88 WORKLOAD
TABLE 10.6.1-1

PART CONTROL NUMBER (PCN)	FY 88 INDUCTIONS				TOTALS
	1ST QTR	2ND QTR	3RD QTR	4TH QTR	
06692A	55	27	49	49	180
50164A	4	14	12	12	42
50266A	0	0	3	1	4
50454A	1	3	3	5	12
51402A	5	3	2	5	15

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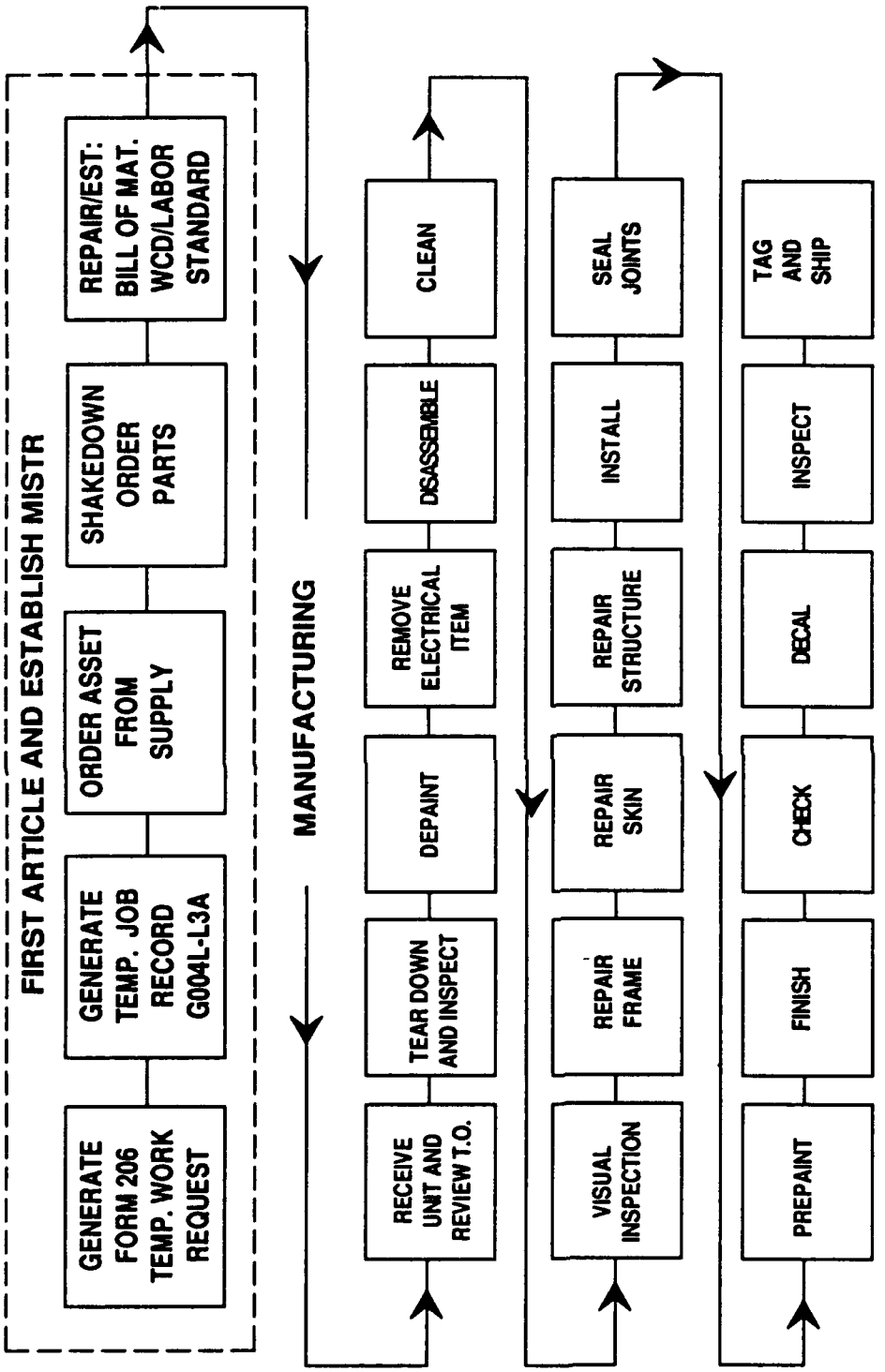
All of the aircraft assemblies to be inspected and repaired are received in Building 169 and are disassembled as required per the applicable technical order for inspection/repair/modification. Figure 10.6.1-1 is a general sheet metal process flow chart for RCC MANPSC. They are reworked to incorporate all the aircraft modifications and technical order changes to meet the required configuration for the aircraft.

The sheet metal and composite components are either repaired to a serviceable condition or are replaced with new parts. In order to repair damaged members of the minor or major structural component of the unit, the repairs may consist of the following: removing local corrosion; replacing damaged sections and those sections with major corrosion; replacing angles, brackets, and rivets; fabricating special repair plates; etc.

The facility layout drawings of Building 169 represent the existing As-Is condition. The drawings entitled Master Shop Layout File Building 169 were updated as of April 1989 and are of good quality.

Material handling in MANPSC involves the use of overhead cranes, slings, manpower, holding and transport dollies, and work carts. All the large and heavy items such as the C-130 Elevator and the C-130 Flaps, etc., are loaded into and out of the check and assembly jigs and fixtures by the use of cranes and slings. Some of the assemblies are moved and positioned by "manpower," requiring several workers to accomplish the task. Some of the assemblies are manually moved and/or flip-flopped or taken in and out of the jig or fixture as many as six or seven times before completion.

The only dedicated storage in the MANPSC area is several parts handling and storage bins in the general areas. Large assemblies are stored within the production area, making working conditions difficult. Large items not in work should be returned to outside storage, not stored in Building 169. The flap assemblies and other large, bulky items are normally stored in wooden crates outside the MANPSC area.



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MANPSC SHEET METAL PROCESS FLOW CHART
FIGURE 10.6.1-1

10.6.2 Statistical System Performance Measures

MANPSC performs some adhesive bonding work and conventional sheet metal work for C-141 and C-130 end items. The WR-ALC/MDMSC TI-ES team selected PCNs 06691A, 50164A, 51402A, 50226A, and 50454A to represent the typical repair work performed in this RCC. The team's process characterization of these PCNs included gathering data via:

- Interviews with ALC/RCC personnel.
- WCD historical information with scheduling personnel assistance.
- Maintenance and production interviews concerning equipment MTBF and MTTR.

This profile data sheet information was then transferred to personal computer files using a Lotus 1-2-3 database storage system. After data verification, flat files for this RCC were generated. Simulation runs were then executed utilizing UDOS 2.0.

The WR-ALC/MDMSC TI-ES team, along with an AFLC representative, performed a statistical comparison of the UDOS 2.0 model simulation outputs for the FY 88 MANPSC repair process. The validation was performed by comparing average simulated flow times to historical flow times and average simulated throughput to FY 88 throughput. The WR-ALC/MDMSC team set a 90% confidence level as minimum acceptance criteria in both areas.

Throughput of MANPSC PCN were within the 90% confidence level factor. Comparison of average simulated versus average historical flow times revealed a substantial difference. The main reason for the flow time difference was back shop flow time. ALC/MDMSC reviewed the back shop hours for all the PCNs with AFLC representatives and changed the interview hours to historical hours. After implementing these changes the model output was reviewed and found within the criteria. The results are discussed in detail in section 6.0 of the DDB to be for MANPSC. The statistics then generated by the simulation model were within an acceptable range when compared to the As-Is condition. This simulation model database represents the As-Is condition for FY 88 and is a baseline for comparison purposes.

Brainstorming was performed during the model validation of RCC MANPSC. Representatives from production, scheduling, planning, quality and industrial engineering from WR-ALC and MDMSC participated in this session. Suggestions to reduce flow time and increase throughput were recommended and points noted. A "fishbone" (cause and effect) diagram was developed from these suggestions and is graphically depicted in section 9.0 of MANPSC's DDB.

The WR-ALC/MDMSC TI-ES team agreed to use the following assumptions and control factors to evaluate the effect on throughput after reviewing the model output and the brainstorming session:

- Workload for MANPSC will be 130% of FY 88 workload.
- No change to manpower quantity.
- Following changes were made to analyze their impact on throughput and was classified a Base, Base+ and Base++ (reference Table 10.6.2-1).

The L_9 Taguchi Array was constructed based on the above assumptions and factors and is depicted in Table 10.6.2-2. The table shows the overall throughput percentages for the PCNs that were profiled. The table also lists the individual PCNs which showed the best and worst throughput percentage under each experimental run.

Analysis of the experimental runs indicates throughputs at base condition were around 96%, but, throughputs at both Base+ and Base++ were considerably low. Base+ and Base++ utilizes the modified fixture and pseudo WCD for C-141 Aft Cowl. The throughput for Base+ varied from 23% to 63% and for Base++ from 35% to 92%.

Evaluation of PCNs by best and worst condition revealed that PCN 06692A, C-141 Aft Cowl, does have low throughput. Comparing the throughput between Base+ and Base++ showed increasing throughput when the quantity of fixtures is increased. This supports our focus study recommendation of redesigning and modifying the C-141 Aft Cowl jig.

MANPSC CONTROL FACTORS
TABLE 10.6.2-1

BASE	BASE+	BASE++
• INCREASE FY 88 WORKLOAD BY 130%. • ALL OTHER FACTORS REMAIN IN THE AS-IS CONDITION.	• INCREASE FY 88 WORKLOAD BY 130%. • WRITE PSUEDO WCD FOR C-141 AFT COWL - PCN 05502A. • USE 8 SETS OF MODIFIED FIXTURES FOR C-141 AFT COWL	• INCREASE FY 88 WORKLOAD BY 130%. • WRITE PSUEDO WCD FOR C-141 AFT COWL - PCN 05502A. • USE 10 SETS OF MODIFIED FIXTURES FOR C-141 AFT COWL

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MANPSC SHEET METAL SHOP TAGUCHI ORTHOGONAL ARRAY

TABLE 10.6.2-2

RUN #	FACTORS & LEVELS						WORKLOAD (THROUGHPUT)		
	MANPOWER			OVERTIME		EQUIPMENT	INDUCTIONS: 560: 130% OF FY 88		
	1	2	3	SAT	SUN		AVG.	BEST	WORST
1	ALL					BASE	91.4 %	51402A 104.5 %	06692A 92.5 %
2	ALL			YES	YES	BASE +	36.6 %	51402A 96.0 %	06692A 23.0 %
3	ALL			YES	YES	BASE ++	44.0 %	51402A 96.0 %	06692A 35.0 %
4	50%	50%				BASE ++	60.5 %	51402A 96.0 %	06692A 53.0 %
5	50%	50%		YES	YES	BASE	98.7 %	51402A 104.0 %	50164A 92.0 %
6	50%	50%		YES	YES	BASE +	56.0 %	51402A 96.0 %	06692A 47.0 %
7	1/3	1/3	1/3			BASE +	68.4 %	51402A 96.0 %	06692A 63.0 %
8	1/3	1/3	1/3	YES	YES	BASE ++	91.4 %	51402A 96.0 %	06692A 92.0 %
9	1/3	1/3	1/3	YES	YES	BASE	98.5 %	51402A 104.0 %	50164A 94.0 %
SURGE*	50%**	50%**				BASE	60.0 %	51402A 110.0 %	06692A 53.0 %

NOTES:
* INDUCTIONS = 579 (2 QTRS)
** TWO 12 HOUR SHIFTS.

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To evaluate the RCC MANPSC capability to respond to surge condition, the following assumptions were considered by WR-ALC/MDMSC team.

- Same manpower as in FY 88.
- Same equipment as in FY 88.
- Spread the manpower between two 12-hour shifts, five days a week
- Increase the FY 88 workload by surge factor, which was provided by AFLC for weapon system serviced by WR-ALC.

An experimentation run was executed with the above assumptions for two quarters. The average throughput for two quarters was only 60%. Review of output reveals that PCN 06692A had a problem in attaining acceptable throughput due to manpower. Both WG-10 and WG-8 are utilized 99%, and the average queue quantity for WG-10 is approximately 255. With the given surge factor, the model indicates this RCC has a potential manpower problem in meeting surge requirement.

10.6.3 Description of Process Problems

The process problems associated with the current MANPSC repair and refurbishment work are the type of problems that usually impact performance. They are defined as inadequate space, lack of/or inadequately trained manpower, inadequate equipment or hand tools, and inefficient working jigs.

Supervision, or lack of proper direction, does not appear to be a contributing factor regarding these problems.

The current method of man-handling the large, high-value assemblies such as the C-144 Aft Cowl units is not good. It subjects skin surfaces to damage that could be prevented by using a holding fixture, allowing the part to be rotated and locked in place while work is being performed. The holding fixture would also better utilize the overhead crane and sling when loading and unloading from the jigs.

10.6.4 Recommended Focus Study: RCC MANPSC/WR-ALC To Redesign and Modify the Existing C-141 L/R Aft Cowling Jigs to Increase Jig Utilization Time From the Present 20% to a Goal of 90%

This focus study will provide a detailed investigation and analysis of the C-141 Aft Cowl repair process technology currently being utilized in MANPSC to paint strip, clean, disassemble, repair, modify, inspect, and paint. The focus study will also determine how to improve methods to attain this increase in jig efficiency and determine the optimum quantity of working jigs required. This will improve throughput for war time surge requirements.

Table 10.6.4-1 details the areas that will be affected by this focus study. Also shown is the MDMSC assessment of the level of effort required in the focus study to evaluate individual areas of analysis.

10.6.4.1 Rationale Leading to Change

The repairing of the C-141 Aft Cowl left and right hand assemblies in Building 169 at WR-ALC requires a flow time of 29 days each and a process time somewhere in excess of 275 manhours, for a yearly induction of 180 units (for 1988/1989).

The C-141 Aft Cowls appear to be an excellent candidate for an experimentation run and focus study for MANPSC RCC. This is due primarily to the possibility of designing a working jig/fixture for use where the cowl may be loaded by an overhead crane into the jig. The cowl would be pinned in on both ends in a rigid position. The fixture would be designed to have rotating and locking capability. This would allow the cowl to be adjusted to any desired clocking position for easy access for repair and/or reshimming while in the jig.

Jig utilization is estimated to be at about 20% at the present. The redesign of the jig is predicted to increase jig utilization to about 90%. Some minor work, such as that involving skin fasteners and a few close-out rivets on the ends, will still require the use of the holding cradle.

C-141 AFT COWL FOCUS STUDY NO. 4 CRITERIA CHECKLIST

TABLE 10.6.4-1 (SHEET 1 OF 2)

AREA OF ANALYSIS	ACTIVITY (WHAT & HOW)	LEVEL OF EFFORT		
		MIN	AVG	MAX
Process/Material Flow	The process flow will increase due to the increased usage of the jig, 20% vs. 90%, and the number of additional jigs to provide optimum vs. required workload will be determined.			X
Equipment/Work Place Layout	The new jigs/tools/layout will improve throughput productivity due to the dedicated work place and workstation(s) for both new and old equipment.			X
Facility Requirements	The existing facility/space requirements in Building 169 should not change.		X	
Labor Standards	The existing labor standards (WCDs, etc.) will require revisions to show the best utilization of all pay labor grades in MANPSC RCC.		X	
Manpower	The manpower requirements will be reduced and/or the existing manpower will be used more efficiently.			X
Task Assignments	All task assignments will change due to additional equipment. This will be fully explored in the study to define maximum utilizations.	X		
Material Requirements	The material requirements will not change. The same repair schemes will be used.	X		
Scrap Rates	No changes anticipated.	X		

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C-141 AFT COWL FOCUS STUDY NO. 4 CRITERIA CHECKLIST

TABLE 10.6.4-1 (SHEET 2 OF 2)

AREA OF ANALYSIS	ACTIVITY (WHAT & HOW)	LEVEL OF EFFORT		
		MIN	AVG	MAX
Material Handling & Storage Methods	The Aft Cowl units wil be moved and positioned by overhead crane and sling in lieu of manhandling. The entire handling and storage will be reviewed.			X
Inspection Techniques	Inspection operations remain the same.	X		
Equipment/Tools/Fixtures	The new jigs/tools/fixtures and tooling system will improve work efficiency and increase throughput. This is the main thrust of the focus study.			X
Process Delays	MDMSC will identify and quantify positive effects of implementing recommended jigs/tools/fixtures.		X	
Part Identification	Remain the same.	X		
Quality	Reduced handling and better access will improve the quality of repair.		X	
Personnel Safety	The reduced handling by mechanics in lieu of overhead/crane/sling will make for a safer environment.			X
Environmental Assessments	Remain the same.	X		

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The cowls are currently being manhandled about five to six times in and out of the main jig or the cradles while being turned or rotated for accessibility. Each turning or rotation requires several mechanics and takes somewhere between ten to15 minutes.

Several cowl assembly jigs were purchased by WR-ALC in the past from Rohr, Chula Vista, the main sub-contractor for Lockheed for the C-141 Aft Cowls. MDMSC investigation has disclosed that these jigs were not suitable for repair work and were ultimately removed from the repair line. It is not known where these jigs are located, but it is possible that the frames could be salvaged and used for the new jigs.

The main problems associated with the old Rohr-type jigs are:

- Space insufficient for workers who are needed to make repairs using the existing jigs.
- Jigs loaded manually.
- Part cannot to be rotated, requiring its complete removal from the jig and the extra support cradles to complete the rework

A cursory investigation by MDMSC has disclosed that neither MANPSC supervision nor the workers were consulted prior to the purchase of the Rohr jigs for the aft cowl rework/repair effort.

This focus study will involve a detailed human factors study and investigation including interviews with the cognizant work force to determine the best possible work station arrangements for the new jigs. Floor space may have to be increased to provide a dedicated work area, such as is currently available for the C-141 Nozzle repair effort in MANPSD, Building 603.

10.6.4.2 Potential Cost Benefits

An annual recurring cost savings of $537,316 occurs from increased labor efficiencies and improved first-time quality due to the implementation of the recommended improvements, as shown in Table 10.6.4-2.

SUMMARY OF INVESTMENT COST AND ANNUAL SAVINGS (CONSTANT FY89 DOLLARS)

TABLE 10.6.4-2 (SHEET 1 OF 2)

	CURRENT ANNUAL COSTS	PROPOSED CHANGE	
		INVESTMENT COSTS	ANNUAL COSTS
NONRECURRING COSTS (1)			
FOCUS STUDY	$0	$460,000 (2)	$0
FACILITIES			
LAND	$0	$0	$0
BUILDINGS	$0	$0	$0
SUPPORT EQUIPMENT			
DEVELOPMENT	$0	$0	$0
ACQUISITION	$0	$600,000 (3)	$0
INSTALL & CHECKOUT	$0	$60,000 (4)	$0
LOGISTICS SUPPORT			
INITIAL SPARES	$0	$0	$0
INITIAL TRAINING (DEV & PRESENTATION)	$0	$20,230 (5)	$0
TECHNICAL DATA	$0	$0	$0
TOTAL NONRECURRING COST	$0	$1,140,230	$0
RECURRING COSTS (1)			
TOUCH LABOR	$1,564,695 (6)	$0	$1,027,379 (7)
SUPPORT EQUIP MAINT	$0	$0	$0
SPARES AND SPARES MGMT	$0	$0	$0
TECHNICAL DATA	$0	$0	$0
MOD KITS	$0	$0	$0
CONFIGURATION DATA MGMT	$0	$0	$0
UTILITIES	$0	$0	$0
TOTAL RECURRING COSTS	$1,564,695	$0	$1,027,379
TOTAL COSTS	$1,564,695	$1,140,230	$1,027,379
ANNUAL COST SAVINGS	$537,316		

NUMBER OF MONTHS FOR FOCUS STUDY	6
NUMBER OF MONTHS TO IMPLEMENT CHANGES	12

SUMMARY OF INVESTMENT COST AND ANNUAL SAVINGS (CONSTANT FY89 DOLLARS)
TABLE 10.6.4-2 (SHEET 2 OF 2)

NOTES:

(1) ONLY ITEMS THAT ARE SIGNIFICANTLY AFFECTED BY THE PROPOSED CHANGE HAVE BEEN ESTIMATED

(2) ENGINEERING ESTIMATE FOR USE IN ENGINEERING TRADE STUDIES ONLY, DOES NOT REPRESENT FIRM PRICING

(3) NEW AND/OR IMPROVED AFT COWL TOOLING ESTIMATED COST OF $100K/NEW TOOL AND $50K/IMPROVED TOOL BASED ON CONVERSATIONS WITH RCC PERSONNEL REGARDING PREVIOUS TOOL MAKE AND PURCHASE COST:

($100,000 X 4) + ($50,000 X 4)

(4) ESTIMATED AT 10% OF SUPPORT EQUIPMENT ACQUISITION COST.

(5) TRAINING OF 16 MECHANICS:

16 X 40 HOURS X $31.61/HOUR

(6) BASED ON ACTUAL LABOR HOURS AND RATE:

180 UNITS X 275 HOURS/UNIT X $31.61/HOUR.

(7) IMPROVEMENT OF 33% DUE TO IMPROVED EFFICIENCY AND GREATER UTILIZATION OF BOTH IMPROVED AND MODIFIED TOOLS/JIGS:

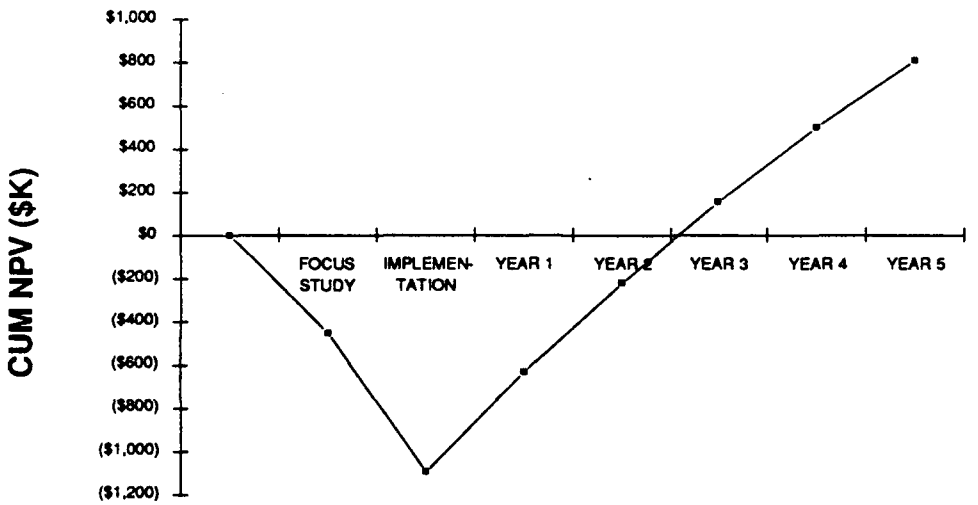
0.67 X 180 UNITS X 275 HOURS/UNIT X $31.61/HOUR.

(8) SAVINGS DUE TO IMPROVED QUALITY - FEWER REWORKS AND RETURNS - ASSUMES 2% SAVINGS:

0.2 X 0.67 X 180 UNITS X 275 HOURS/UNIT X $31.61/HOUR

The investment cost of the recommendations is estimated at $1,140,230. This includes the focus study effort and the implementation cost.

The Cost Benefit Analysis (CBA) shows an Internal Rate of Return (IRR) of 33% and a savings of $806,203 in terms of Net Present Value (NPV) using constant FY 89 dollars (see Figure 10.6.4-1). The CBA is in compliance with regulation AFR173-15, cost analysis procedures, dated 4 March 1988, and rates per AFLCR 78-3.



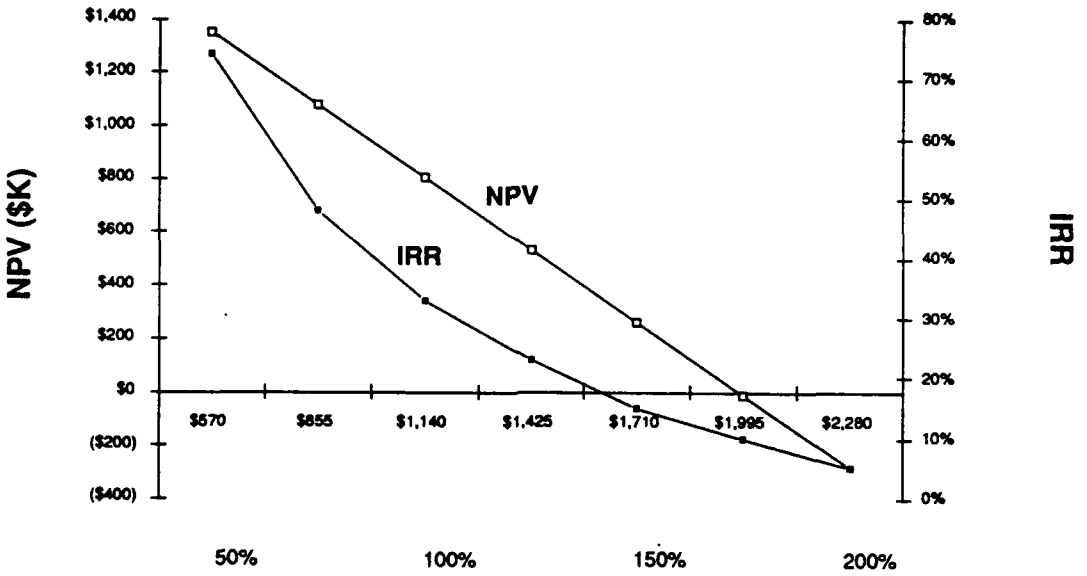
CUM NPV IN CONSTANT FY89 DOLLARS
FIGURE 10.6.4-1

The CBA covers the time frame starting with the focus study through five years after the completion of implementation. The recurring cost savings was assumed to start at the end of implementation.

The NPV takes into account the time value of money and is calculated by discounting a cash flow. The focus study cost, implementation cost, and the recurring savings were spread by fiscal year quarters and discounted back to the first quarter by using a mid-quarter discounting factor equivalent to an annual discount factor of 10%. Basically, this means a dollar that is earned in

FY 90 is worth $.91 in FY 89 terms ($1.00/1.1), due to the ability to borrow or lend at a positive interest rate.

A sensitivity analysis was performed in which the investment cost varied between 50% and 200% of the estimated costs (see Figure 10.6.4-2).



CBA SENSITIVITY ANALYSIS
FIGURE 10.6.4-2

10.6.4.3 Risk Assessment of Achieving Study Goals

The following is a list of the possible risks in achieving the study goals. MDMSC believes these risks are minimal.

- The actual cost savings can be qualified only after the detailed focus study is completed and the optimum recommendations selected for implementation.
- Some risks are inevitable because of the questionable historical data which established the As-Is condition of the current tooling situation.
- Implementation costs will involve some facility assessment and rearrangement which cannot be quantified fully until after the focus study.

10.6.4.4 Duration and Level of Effort

MDMSC recommends a six-month-long focus study period of performance to:

- Research and establish the historical aspect of the As-Is condition of the C-141 Aft Cowl fixture/jig. Create a new WCD that will depict and represent the desired conditions expected out of the new tool plan.
- Assess all technical aspects, facilities and equipment along with performing the related job tasks appraisals necessary for increased tool usage and shorter flow time. The facilities may require expansion and the entire work plan will change.
- Include definite trade-offs, remedial facets of the overall situations, and the promotion of all the potentially positive aspects of the tooling problem.
- Summarize all cost-effective related manufacturing and tooling opportunities for AFLC review.

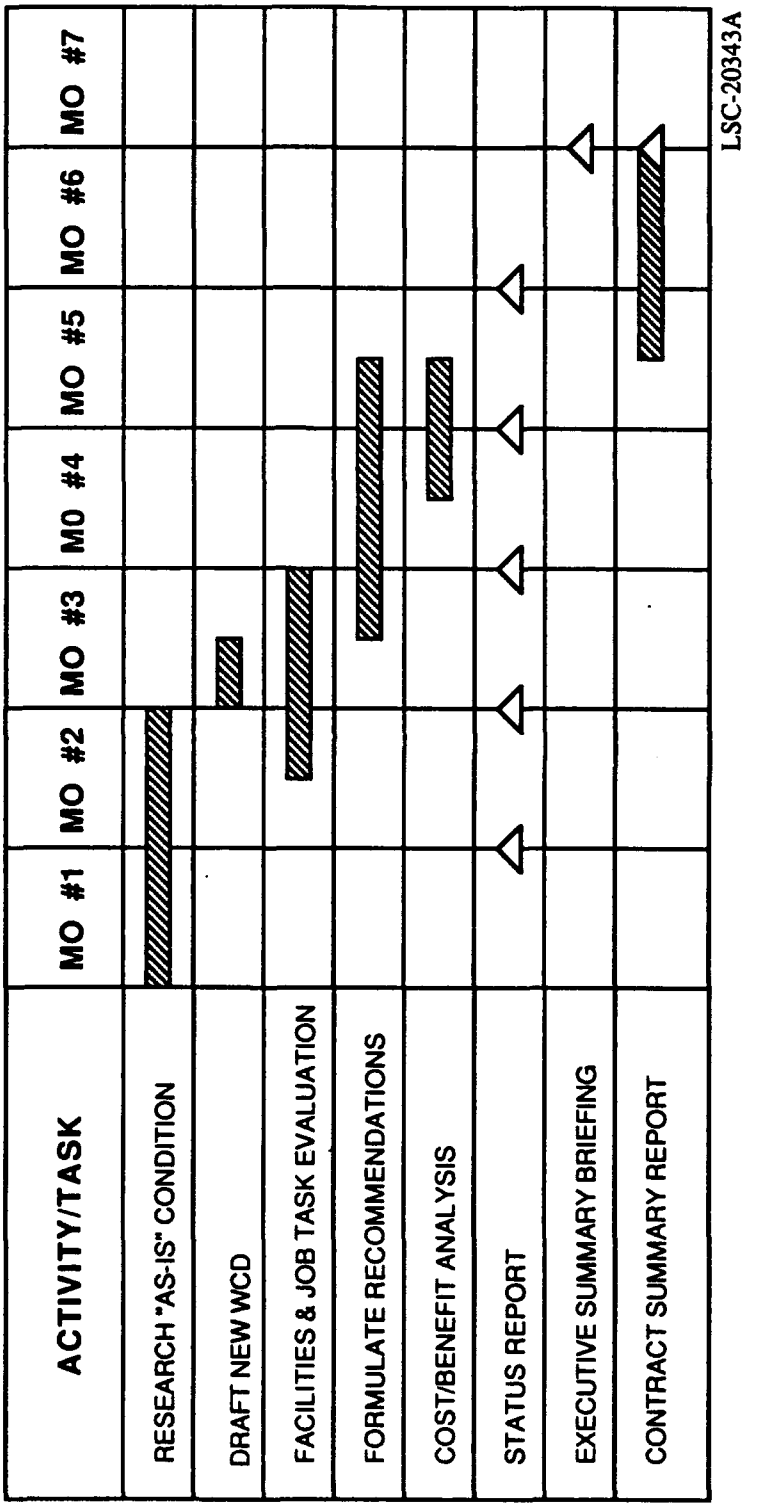
Figure 10.6.4-3 illustrates the proposed schedule to accomplish FSR No. 4.

It is estimated that a total of $460,000 is required to implement this recommendation. This number is a ROM engineering estimate for engineering trade studies only; it does not represent firm pricing.

10.6.5 Recommended Focus Study: Combining C-141 Aileron, Petal Door and Aft Cowl Tooling Jig Redesign Focus Studies

MDMSC proposes combining the three jig redesign focus studies described in paragraphs 10.4.4, 10.4.5, and 10.6.4 into one focus study. Paragraph 10.4.4 describes the aileron jig, paragraph 10.4.5 describes the petal door jig, and paragraph 10.6.4 describes the aft cowling jig.

Repair and refurbishment for MANPSA/MANPSC RCCs associated with the aileron jig, petal door jig and aft cowling jig is all performed in Building 169. The analysis required to modify any one of the three fixtures could be accomplished for all three jigs simultaneously, thereby establishing the most cost effective method of analysis. By performing all three at the same time, the start-up costs would be greatly reduced along with related focus study travel time and costs.



PROPOSED FSR NO. 4 SCHEDULE

FIGURE 10.6.4-3

10.6.5.1 Rationale Leading to Change

In order to increase throughput at RCCs MANPSA and MANPSC, a redesign of the presently used jigs is required. These jigs are not totally suitable for the tasks being performed (reference paragraphs 10.4.4.1, 10.4.5.1 and 10.4.6.1).

10.6.5.2 Potential Cost Benefits

An annual recurring cost savings of $1,283,861 occurs from increased labor efficiency and improved first-time repair quality due to the implementation of the recommended improvements as shown in Table 10.6.5-2.

The investment cost of the recommendations is estimated at $3,080,691. This cost includes the focus study effort and the implementation cost.

The Cost Benefit Analysis (CBA) shows an Internal Rate of Return (IRR) of 27% and a savings of $1,546,418 in terms of Net Present Value (NPV) using constant FY 89 dollars (see Figure 10.6.5-1). The CBA is in compliance with regulation AFR173-15, cost analysis procedures, dated 4 March 1988, and rates per AFLCR 78-3.

The CBA covers the time frame starting with the focus study through five years after the completion of implementation. The recurring cost savings was assumed to start at the end of implementation.

The NPV takes into account the time value of money and is calculated by discounting a cash flow. The focus study cost, implementation cost, and the recurring savings were spread by fiscal year quarters and discounted back to the first quarter by using a mid-quarter discounting factor equivalent to an annual discount factor of 10%. Basically, this means a dollar that is earned in FY 90 is worth $.91 in FY 89 terms ($1.00/1.1), due to the ability to borrow or lend at a positive interest rate.

A sensitivity analysis was performed in which the investment cost varied between 50% and 200% of the estimated costs (see Figure 10.6.5-2).

SUMMARY OF INVESTMENT COST AND ANNUAL SAVINGS (CONSTANT FY89 DOLLARS)

TABLE 10.6.5-2 (SHEET 1 OF 2)

	CURRENT ANNUAL COSTS	PROPOSED CHANGE	
		INVESTMENT COSTS	ANNUAL COSTS
NONRECURRING COSTS (1)			
FOCUS STUDY	$0	$1,040,000 (2)	$0
FACILITIES			
LAND	$0	$0	$0
BUILDINGS	$0	$0	$0
SUPPORT EQUIPMENT			
DEVELOPMENT	$0	$0	$0
ACQUISITION	$0	$1,800,000 (3)	$0
INSTALL & CHECKOUT	$0	$180,000 (4)	$0
LOGISTICS SUPPORT			
INITIAL SPARES	$0	$0	$0
INITIAL TRAINING (DEV & PRESENTATION)	$0	$60,691 (5)	$0
TECHNICAL DATA	$0	$0	$0
TOTAL NONRECURRING COST	$0	$3,080,691	$0
RECURRING COSTS (1)			
TOUCH LABOR	$3,738,673 (6)	$0	$2,454,812 (7)
SUPPORT EQUIP MAINT	$0	$0	$0
SPARES AND SPARES MGMT	$0	$0	$0
TECHNICAL DATA	$0	$0	$0
MOD KITS	$0	$0	$0
CONFIGURATION DATA MGMT	$0	$0	$0
UTILITIES	$0	$0	$0
TOTAL RECURRING COSTS	$3,738,673	$0	$2,454,812
TOTAL COSTS	$3,738,673	$3,080,691	$2,454,812
ANNUAL COST SAVINGS	$1,283,861		

NUMBER OF MONTHS FOR FOCUS STUDY	9
NUMBER OF MONTHS TO IMPLEMENT CHANGES	12

SUMMARY OF INVESTMENT COST AND ANNUAL SAVINGS (CONSTANT FY89 DOLLARS)
TABLE 10.6.5-2 (SHEET 2 OF 2)

NOTES:

(1) ONLY ITEMS THAT ARE SIGNIFICANTLY AFFECTED BY THE PROPOSED CHANGE HAVE BEEN ESTIMATED

(2) ENGINEERING ESTIMATE FOR USE IN ENGINEERING TRADE STUDIES ONLY, DOES NOT REPRESENT FIRM PRICING

(3) NEW AND/OR IMPROVED TOOLING ESTIMATED COST OF $200K OR $100K/NEW TOOL AND $100K OR $50K/IMPROVED TOOL BASED ON CONVERSATIONS WITH RCC PERSONNEL REGARDING PREVIOUS TOOL MAKE AND PURCHASE COST:

AILERON = ($200,000 X 4) + ($100,000 X 4)
PETAL DOOR = ($200,000 X 4) + ($100,000 X 4)
AFT COWL = ($100,000 X 4) + ($50,000 X 4)

(4) ESTIMATED AT 10% OF SUPPORT EQUIPMENT ACQUISITION COST.

(5) TRAINING OF 48 MECHANICS:

48 X 40 HOURS X $31.61/HOUR

(6) BASED ON ACTUAL LABOR HOURS AND RATE:

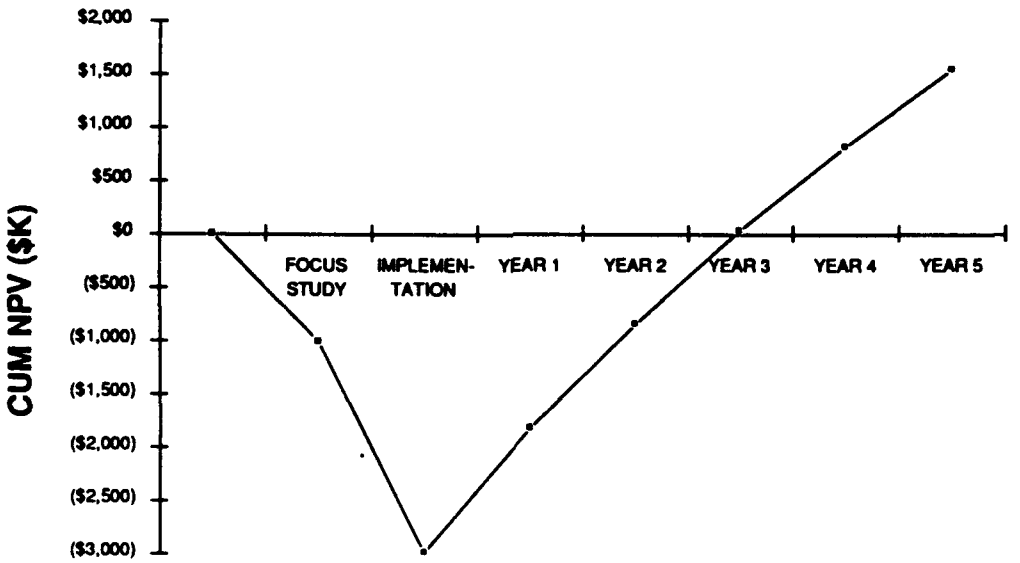
AILERON = 101 UNITS X 420 HOURS/UNIT X $31.61/HOUR.
PETAL DOOR = 35 UNITS X 502 HOURS/UNIT X $31.61//HOUR.
AFT COWL = 180 UNITS X 275 HOURS/UNIT X $31.61HOUR.

(7) IMPROVEMENT OF 33% DUE TO IMPROVED EFFICIENCY AND GREATER UTILIZATION OF BOTH IMPROVED AND MODIFIED TOOLS/JIGS:

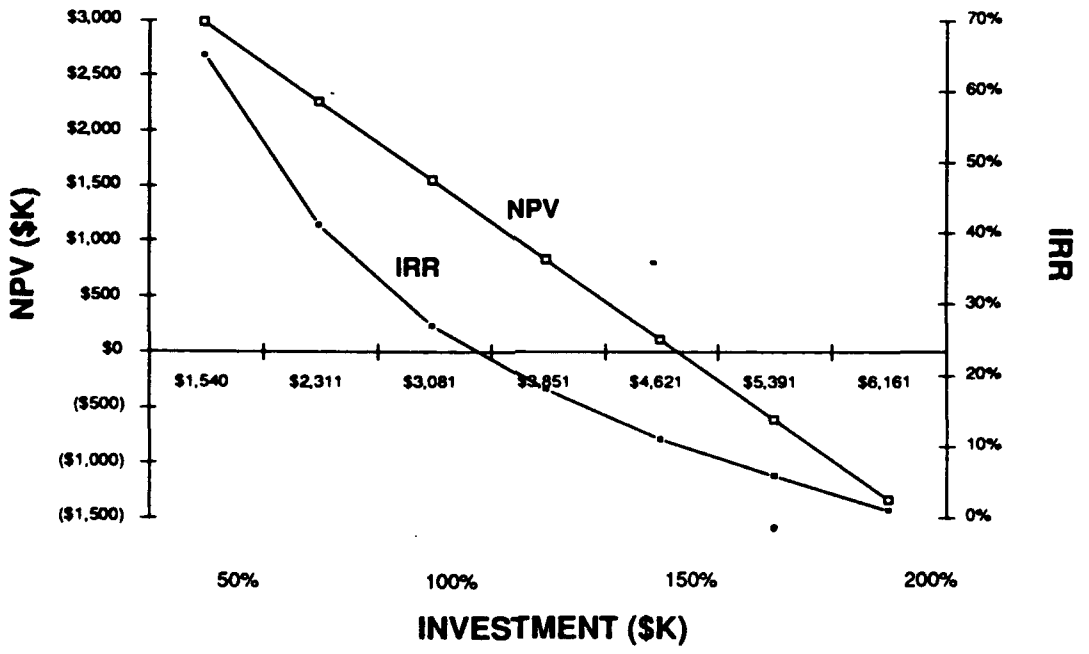
AILERON = 0.67 X 101 UNITS X 420 HOURS/UNIT X $31.61/HOUR.
PETAL DOOR = 0.67 X 35 UNITS X 502 HOURS/UNIT X $31.61/HOUR.
AFT COWL = 0.67 X 180 UNITS X 275 HOURS/UNIT X $31.61/HOUR.

(8) SAVINGS DUE TO IMPROVED QUALITY - FEWER REWORKS AND RETURNS - ASSUMES 2% SAVINGS:

AILERON = 0.2 X 0.67 X 101 UNITS X 420 HOURS/UNIT X $31.61/HOUR.
PETAL DOOR = 0.2 X 0.67 X 35 UNITS X 502 HOURS/UNIT X $31.61HOUR.
AFT COWL = 0.2 X 0.67 X 180 UNITS X 275 HOURS/UNIT X $31.61/HOUR.



CUM NPV IN CONSTANT FY89 DOLLARS
FIGURE 10.6.5-1



CBA SENSITIVITY ANALYSIS
FIGURE 10.6.5-2

10.6.5.3 Risk Assessment of Achieving Study Goals

The following is a list of the possible risks in achieving the study goals. MDMSC believes these risks are minimal.

- The actual cost savings can be qualified only after the detailed focus study is completed and the optimum recommendation is selected for implementation.
- Some risks are inevitable because of the questionable historical data which established the As-Is condition of the current tooling situation.
- Implementation costs will involve some facility assessment and rearrangement and cannot be quantified until completion of the focus study.

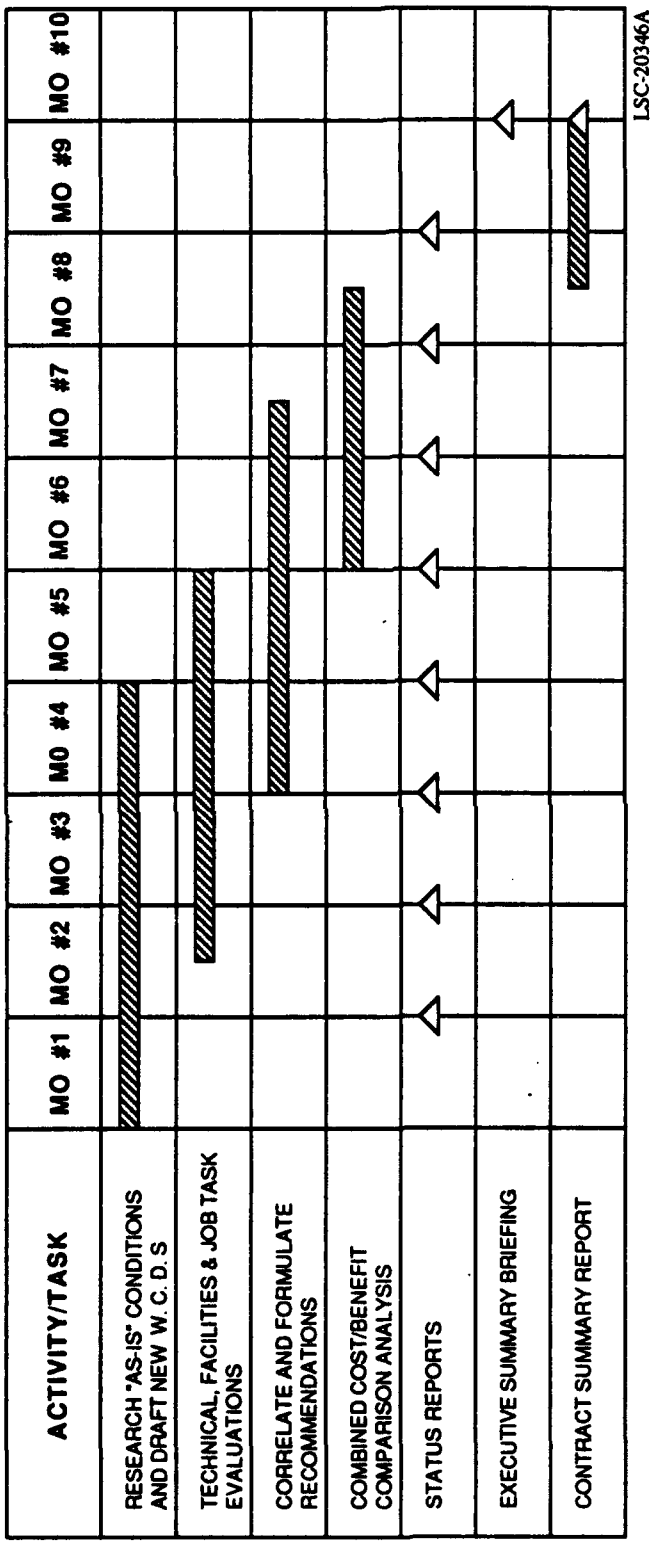
10.6.5.4 Duration and Level of Effort

MDMSC recommends a nine-month-long focus study period of performance to:

- Research and establish the historical aspect of the As-Is condition of the current subject fixtures/jigs. Create new WCDs that will depict and represent the desired conditions expected from the new tool plans.
- Assess all technical aspects, facilities, and equipment, along with performing the related job task appraisals necessary for increased tool usage and shorter flow time. The facilities may require expansion, and the entire work plan will change.
- Include definite trade-offs, remedial facets of the overall situations, and the promotion of all the potentially positive aspects of the tooling problem.
- Summarize all cost-effective related manufacturing and tooling opportunities for AFLC review.

Figure 10.6.5-3 illustrates the proposed schedule to accomplish FSR No. 5.

It is estimated that a total of $1,040,000 is required to implement this recommendation. This number is an ROM engineering estimate for engineering trade studies only; it does not represent firm pricing.



PROPOSED COMBINED FOCUS STUDY NO. 5 SCHEDULE
FIGURE 10.6.5-3

10.6.6 Other Observations

The other observations described in this section were not considered as focus studies or quick fixes because they had a less significant impact on the areas of time, quality, or cost. These observations are recorded to assist WR-ALC in developing ideas that will further enhance their operations.

The observations which follow were originally identified as Quick Fix and Focus Study improvement opportunities and are detailed as such in the MANPSC DDB. After review by the MDMSC/WR-ALC TI-ES team, it was mutually agreed that they should be presented as other observations for future reference.

Environmental Improvement Opportunities

- Review Safety Precautions for Cleaning Solvent
  - Current Condition: Methyl Ethyl Ketone (MEK) is used as a cleaning solvent. MEK is a flammable material, and an irritant to workers.
  - MDMSC Recommendation: Another cleaning solvent may be used instead of the MEK. 1,1,1-Trichloroethane could be used as a replacement because it is nonflammable, thus less hazardous than MEK. This recommendation would need to be studied further to determine if this solvent would clean WR-ALC's parts to the standards. Other studies are currently being performed by the AFLC to evaluate substitute solvents which are less hazardous than either MEK or 1,1,1-Trichloroethane.

General Area Improvement Opportunities

- Use Lockheed "Status" to Determine Drawing Changes and Effectivity
  - Current Condition: There seems to be a bit of confusion at WR-ALC as to how to determine the effectivity of a part or of a drawing revision. This is especially pertinent to the drawings and parts for the Lockheed C-130 and C-141 aircraft. When the Air Force bought these airplanes from Lockheed, they also bought the drawings and the drawing submittal system, which would be in accordance with the applicable military specification for the drawing requirements.

- MDMSC Recommendation: A phone call to "Status" at Lockheed could get an answer whenever a problem arises involving whether a C-130/C-141 part is required on a particular model. "Status" could also be used to verify the latest drawing revision or Engineering Order change to a drawing.

Operational Improvement Opportunities

- Review/Allocate Sufficient and Dedicated Work Space for Each Workstation
  - Current Condition: There is much confusion now in certain areas because of the lack of dedicated and sufficient space in which the mechanic may work. Traffic cross-flow is bad, and in some instances, there is no assigned space for the mechanic to work. Observations of several areas in Building 169, such as the areas for the petal doors and ailerons for the C-141, justified this conclusion.
  - MDMSC Recommendation: The work space for a given repair task must be adequate to allow the work to be performed in the most timely and cost effective manner. Each work station must be designed, and enough space allotted, to allow the mechanic to be able to work without interruption from other people nearby, cross-flow traffic from fellow workers, and other confusion. MDMSC recommends, as a stop gap measure before an in-depth facilities layout can be made, that each work station be identified and permanently marked so that the mechanic assigned to that work station may work with a minimum of interruptions. Rails or fences should be considered to outline the stations.

Management Improvement Opportunities

- Put More Emphasis on QP4
  - Current Condition: Some RCC repair units do not have an active QP4 team. Where QP4 teams are established, they are not allotted the necessary time to be effective. The lack of manpower seems to be a problem.

- MDMSC Recommendation: Long standing, complicated problems have a greater chance of being solved when a QP4 team is active in the area. More emphasis should be placed on the QP4 team effort, and on using them with greater visibility and recognition as problem solvers. The QP4 teams are currently being revised and restructured. It is suggested that more recognition and authority be given to these teams.

- Include the Supervisor When Decisions are Made Affecting Quality/Production
  - Current Condition: Decisions are made sometimes that affect the production effort or the quality of a repair unit without the supervisor being told or asked to participate in the decision making process.
  - MDMSC Recommendation: Better solutions to MANPS problems may be realized by forming a task force composed of those individuals most knowledgeable and intimately concerned with finding a solution to the problem at hand. Examples: the production supervisor, if the problem involves the production effort; the tooling expert, if the problem involves a tool change; the planner, if any change is contemplated in the work sequence or planning. The task force should always be lead by the production supervisor if the problem involves production or quality.

Process Capability Opportunities

- Utilize the Planning Section for Help for All Manufacturing Coordination
  - Current Condition: When mechanics have problems pertaining to engineering and other data requirements for a particular unit being repaired, they often contact the technical support people (manufacturing, tooling, facilities, materials engineering, etc.) in a direct manner. Usually, the mechanics are not as well versed as the planner regarding the overall part requirement and design intent.

- MDMSC Recommendation: Make better use of the planning section to help solve all problems involving the technical implementation of the WCD. The mechanic should take the problem first to the planner, who will then make the appropriate contact for coordination. When the planner is contacted, he will be in a better position to: 1) Assist the mechanic to prevent work stoppages, 2) Revise the WCD, when required, 3) Coordinate the production effort, 4) Influence the standard hour requirement, and 5) Help solve tooling problems and requirements.

• Utilize the Quality Section for Help for All Repair Problems Involving Quality

- Current Condition: The supervisors and their designees often do not call the quality assurance specialist to help solve problems arising from the repair effort.
- MDMSC Recommendation: The quality assurance specialist should be utilized by issuing a Request for Quality Assistance (RQA) (AFLC Form 354). The quality assurance specialist will use the skills and facilities available to develop valid solutions or recommendations on all RQAs. Examples include; Quality Engineering, Methods Improvement Laboratory, Chemical or Materials Laboratories, and other subject matter specialists from their divisions or directorates. The corrective actions will be coordinated with all activities having a primary or collateral responsibility. Time will be reduced and/or work efficiency will be increased. This will result in a production rate increase.

10.7 MANPSD ANALYSIS AND FOCUS STUDY RECOMMENDATIONS

MANPSD, Plastic and Sheet Metal Unit, is a RCC within the MANPS section of the Industrial Products Division (MAN) at WR-ALC.

MANPSD is located in Buildings 603 and 670. The primary workload in MANPSD consists of MISTR work consisting of F-15A and F-15B canopies, F-15 radome, C-141 engine exhaust nozzle, C-141 wing leading edges, C-130E radome, and the C-130A radome assembly.

During initial characterization of the MANPSD RCC, a total of 19 potential improvement opportunities were identified (reference MANPSD Database Documentation Book, Potential Improvement Opportunities section). After review of this original set of opportunities by the MDMSC/Air Force team, six improvement opportunities were selected to be pursued as the focus of the TI-ES Program activities relating to MANPSD.

None of the improvement opportunities were selected to be presented as focus studies for MANPSD.

The six quick fixes applicable to RCC MANPSD are summarized below.

- Develop a Mechanic's Handbook for Each Repaired Assembly
  Recommended to complement and supplement the Technical Orders and document all major steps and techniques of each repaired assembly unit. The manual would be invaluable to new or less experienced mechanics in a rapid build-up surge or war-time readiness situation or where a production rate increase would be necessary such as the present F-15 wing repair effort.

- Implement Program for the Mechanic to Buy and Maintain Own Handtools
  Recommended to eliminate/reduce the number of tools/boxes/stands, tool crib manpower and purchasing expense. The plan will provide the necessary tools and make the worker responsible for the tool inventory and the replacement of broken handtools.

- Provide Pictorial Drawings With the Existing Workbooks(WCDs)
  Recommended to assist the worker to better understand the required task and to help train others in a surge or war-time emergency situation.

- Provide Holding/Support Fixtures for All Radomes
  Recommended to hold the radome on its side and to allow the radome to be rotated. This method would be similar to the holding fixture currently being used on the C-141 nozzle repair effort. This new support stand will provide better access and less worker strain.

- Brush Alodine Treatment Capability for Building 603
  Recommended to eliminate the transportation of parts to Building 180 about two miles away. This is currently under study for both a temporary and a permanent solution to the situation.

- Make Available Cobalt-Tipped Drill Bits, or Equivalent
  Recommended in lieu of resharpened drill bits, for the mechanic's use to drill out aluminum rivets and other type fasteners such as steel bolts and blind steel rivets.

These quick fixes offer benefits to MANPSD in terms of quality, time, and cost, and are described in detail under separate cover (reference Technology Insertion-Engineering Services Process Characterization, Task Order No. 1, Volume VII Quick Fix Plan WR-ALC, MANPSD Quick Fix opportunities section).

The remainder of the original MANPSD improvement opportunities are presented as other observations and are described in paragraph 10.7.4.

10.7.1 Description of Current Operations

MANPSD is comprised mainly of conventional sheet metal and certain specialized composite material fabrication equipment in Buildings 603 and 670. MANPSD has large assembly and check fixtures, rivet installation holding fixtures, fixed tables and dollies, a mobile lifting crane, transport dollies, drying ovens, and other ordinary composite support equipment.

MANPSD has the necessary hand tools and process equipment to manufacture and repair composite sandwich structure normally used in Radome and Canopy repair.

MANPSD also has the normal sheet metal equipment needed to support the MISTR workload such as hand brakes, hand formers, drill press, band saw, hole punch, bench grinder, as well as all the rivet driving and upsetting tools necessary to support the numerous types of fasteners used in repair/overhaul work for sheet metal and fiberglass structure.

MANPSD has the necessary test equipment and test facilities to conduct tests on sending/receiving capabilities of repaired radomes. This testing procedure also confirms repairs and splice effects on the critical "window" areas of the radomes.

The equipment within MANPSD varies in age between ten and twenty years old. The majority of the equipment is in good working condition. New replacement pieces of equipment are being planned for purchase. A listing of major equipment for MANPSD can be found in the equipment profile list in Section 5.0 of the DDB.

The repair process technologies within MANPSD consists of major unit manufacturing and conventional sheet metal/fiberglass, honeycomb bonded and composite repairs on high value C-130, C-141, and F-15 major aircraft assemblies. These assemblies are critical to flight safety and the performance

of the aircraft in their assigned mission. Table 10.7.1-1 depicts the PCNs involved in the 80/20 workload analysis of the FY 88 workload for RCC MANPSD.

MANPSD PLASTIC/SHEET METAL SHOP FY 88 WORKLOAD
TABLE 10.7.1-1

PART CONTROL NUMBER (PCN)	FY 88 INDUCTIONS				TOTALS
	1ST QTR	2ND QTR	3RD QTR	4TH QTR	
03172A	21	39	31	13	104
03427A	6	2	0	2	10
09193A	16	27	29	21	93
40208A	8	15	7	11	41
41059A	13	14	24	36	87
51344A	16	18	14	10	58
51420A	2	0	2	8	12

LSC-20300A

Material handling in MANPSD involves the use of a mobile crane, slings, manpower, holding and transport dollies, and work carts.

All the large and heavy items such as the F-15 Canopies and C-130 Radomes are loaded into and out of the holding fixtures and dollies by the use of cranes and slings. Some of these assemblies are rotated/turned manually, requiring several workers to accomplish the task.

The only dedicated storage in the MANPSD area is several parts handling and storage bins. Large assemblies are occasionally stored within the work area making it difficult to work. The large items not being used should be returned to

outside storage and not in Buildings 603 and 670. The large bulky items are normally received and stored in wooden crates outside the MANPSD area.

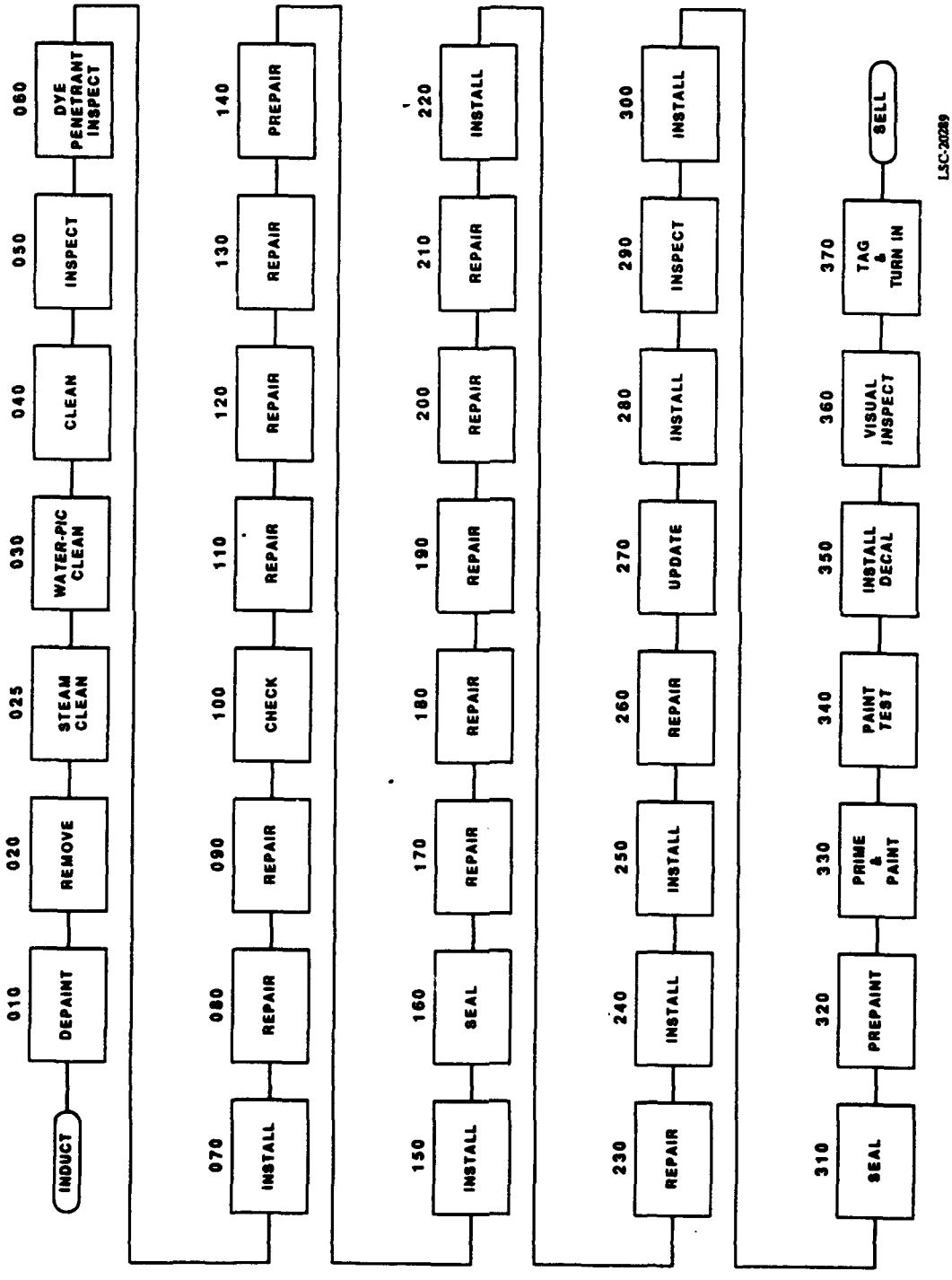
All of the aircraft assemblies to be inspected and repaired are received in Buildings 603 and 670, and are disassembled, as required, per the applicable technical order for inspection/repair/modification. They are reworked to incorporate all the aircraft modifications and technical order changes to meet the required configuration for the aircraft. Figure 10.7.1-1 is a general sheet metal process flow chart for RCC MANPSD.

The workload within MANPSD consists mostly of Management of Item Subject To Repair (MISTR) items. The sheet metal and special composite components are repaired to a serviceable condition, if possible, otherwise they are replaced with new parts. The repairs to damaged members of the minor or major structural component of the unit may consist of removing local corrosion, removing crazed or delaminated fiberglass sections, installing new transparencies, replacing damaged metal sections and those sections with major corrosion, and replacing angles, brackets, rivets, or fabricating special repair plates.

The facility layout drawings of Buildings 603 and 670 represent the existing As-Is condition. The drawings entitled Master Shop Layout File, Buildings 603 and 670, were updated as of April, 1989 and are of good quality, but do not show the latest floor layout including the installation of two drying ovens.

The "Women" toilet facilities for Building 603 are grossly inadequate, with only one commode in a very small space. The "Break Area" for Building 603 is not enclosed; therefore, dirt, dust, noise, etc. interfere with a comfortable break period.

Several C-130 Wing Leading Edge jigs are currently being stored in Building 603. Additional work space for C-141 nozzles could be realized if these unused jigs were stored elsewhere. Also, it was observed that Building 603 is not adequately cooled.



MANPSD PLASTIC/SHEET METAL PROCESS FLOW CHART
FIGURE 10.7.1-1

MANPSD is headed by a unit chief with five supervisors. The unit chief reports to a section chief. The supervisors are knowledgeable of the end items and the repair process. MANPSD has an adequate work force. The work force is well trained and well supervised. Personal interviews have indicated a sense of professionalism and pride among the work force. The work force is comprised mainly of aircraft sheet metal mechanics and the general plastic fabricators and workers, two foremen, one leader in training, a secretary, a tool and parts attendant, and worker trainees.

The following is a list of the available manpower within MANPSD.

Skill Code	Skill Level	Quantity	Experience
11582	WS-14	2	20 yrs.
47881	WS-10	2	15 yrs.
48900	WS-11	3	10 yrs.
48901	WS-09	5	10 yrs.
48903	WS-07	5	8 yrs.
9A014	WS-10	40	8 yrs.
18083	WS-05	7	2 yrs.
9A012	WS-09	30	6 yrs.

MANPSD has adequate support from planning and scheduling departments.

10.7.2 Statistical System Performance Measures

MANPSD repairs F-15, C-141, C-130 radome assemblies in Building 670 and exhaust nozzles in Building 603. The WR-ALC/MDMSC TI-ES team selected PCNs 03172A, 51344A, 09193A, 41059A, 03427A, 40208A, and 51420A to represent the repair work performed in this RCC. The team's process characterization of these PCNs included gathering data via:

- Interviews with ALC/RCC personnel
- WCD historical information with scheduling personnel assistance
- Maintenance and production interviews concerning equipment MTBF and MTTR

This profile data sheet information was then transferred to personal computer files using a Lotus 1-2-3 database storage system. After data verification, flat files for this RCC were generated. Simulation runs were then executed utilizing UDOS 2.0.

The WR-ALC/MDMSC TI-ES team, along with an AFLC representative, performed a statistical comparison of the UDOS 2.0 model simulation outputs for the FY 88 MANPSD repair process. The validation was performed by comparing average simulated flow times to historical flow times and average simulated throughput to FY 88 throughput. The WR-ALC/MDMSC team set a 90% confidence level as minimum acceptance criteria in both areas.

Throughput of MANPSD PCNs were within the 90% confidence level factor. Comparison of average simulated versus average historical flow times revealed a substantial difference. The reason for the difference between simulated and historical flow hours was investigated by ALC/MDMSC representatives. The findings were; that operation ten of PCN 03172A historically takes 1180 hours due to induction practice and the time needed to determine what needs to be done. Also, operation 30 of PCN 40208A historically takes an average of 4000 hours. For all back shop operations, MDMSC used the interview hours which caused the substantial differences. The results are discussed in detail in section 6.0 of the DDB for MANPSD. The statistics then generated by the simulation model were within an acceptable range when compared to the As-Is condition. This simulation model database represents the As-Is condition for FY 88 and is a baseline for comparison purposes.

Brainstorming was performed during the model validation of RCC MANPSD. Representatives from production, scheduling, planning, quality and industrial engineering from WR-ALC and MDMSC participated in this session. Suggestions to reduce flow time and increase throughput were discussed and points noted. A "fishbone" (cause and effect) diagram was developed from these suggestions and is graphically depicted in section 9.0 of MANPSD's DDB.

The WR-ALC/MDMSC TI-ES team agreed to use the following assumptions and control factors to evaluate the effect on throughput, after reviewing the model output and the brainstorming session:

- Workload for MANPSD will be 130% of FY 88 workload
- No change to manpower quantity
- Following changes were made to analyze their impact on throughput and was classified a Base, Base+ and Base++.

Base & Base++: Increase FY 88 workload by 130% and all others remain in the As-Is condition.

Base+: Increase FY 88 workload by 180%. Reduce back shop MANPDD hours by 40%. All other remain in the As-Is condition.

The L_9 Taguchi Array was constructed based on the above assumptions and factors and is depicted in Table 10.7.2-1. The table shows the overall throughput percentages for the PCNs that were profiled. The table also lists the individual PCNs which showed the best and worst throughput percentage under each experimental run.

The results produced by experimental runs indicate that the throughput of RCC MANPSD are all around 100% when manpower is used during weekends. Analysis of PCN 03172A, which had the worst throughput condition, showed an increase in throughput whenever overtime is utilized. Decreasing the back shop MANPDD hours by 40% did not produce any change in throughput. Best throughput was accomplished when the manpower was spread between shifts.

To evaluate RCC MANPSD capability to respond to a surge condition, the following assumptions were considered by WR-ALC/MDMSC team.

- Same manpower as in FY 88.
- Same equipment as in FY 88.
- Spread the manpower between two 12-hour shifts, five days a week.
- Increase the FY 88 workload by the surge factor provided by AFLC for weapon system serviced by WR-ALC.

MANPSD SHEET METAL SHOP TAGUCHI ORTHOGONAL ARRAY

TABLE 10.7.2-1

RUN #	FACTORS & LEVELS						WORKLOAD (THROUGHPUT)		
	MANPOWER			OVERTIME		EQUIPMENT	INDUCTIONS: 531: 130% OF FY 88		
	1	2	3	SAT	SUN		AVG.	BEST	WORST
1	ALL					BASE	79.0 %	03427A 113.0 %	03172A 28.0 %
2	ALL			YES	YES	BASE +	95.8 %	03427A 120.0 %	03172A 85.0 %
3	ALL			YES	YES	BASE ++	95.8 %	03427A 120.0 %	03172A 85.0 %
4	50%	50%				BASE ++	80.0 %	03427A 106.0 %	03172A 21.0 %
5	50%	50%		YES	YES	BASE	100.0 %	03427A 108.0 %	51420A 66.7 %
6	50%	50%		YES	YES	BASE +	100.0 %	03427A 106.0 %	51420A 66.7 %
7	1/3	1/3	1/3			BASE +	76.0 %	03427A 106.0 %	03172A 18.0 %
8	1/3	1/3	1/3	YES	YES	BASE ++	102.0 %	03427A 106.0 %	51420A 72.0 %
9	1/3	1/3	1/3	YES	YES	BASE	102.0 %	03427A 106.0 %	51420A 72.0 %
SURGE*	50%**	50%**				BASE	100.7 %	03427A 106.0 %	51420A 72.0 %

NOTES: * INDUCTIONS = 502 (4 QTRS)
** TWO 12 HOUR SHIFTS.

LSC-20617

Experimentation run was executed with above assumptions for four quarters. The average throughput shows that RCC MANPSD has the capability to meet surge condition. Throughput of PCN 51420A is only 72%, which is caused due to the excessive use of back shop hours. In our experimentation, back shop hours are treated as in peace time.

10.7.3 Description of Process Problems

The intent of this paragraph is to expound on major process problems for which there are focus study recommendations. Since there were no major process problems identified for MANPSD RCC at this time, improvement opportunities addressed in this RCC are identified as other observations in this report or quick fixes in the Quick Fix Plan.

10.7.4 Other Observations

The other observations described in this section were not considered as focus studies or quick fixes because they had a less significant impact on the areas of time, quality, or cost. These observations are recorded to assist WR-ALC in developing ideas that will further enhance their operations.

The observations which follow were originally identified as Quick Fix and Focus Study improvement opportunities and are detailed as such in the MANPSD Database Documentation Book. After review by the MDMSC/WR-ALC TI-ES team, it was mutually agreed that they should be presented as other observations for future reference.

Environmental Improvement Opportunities

- Review Safety Precautions for Cleaning Solvent
  - Current Condition: Methyl Ethyl Ketone (MEK) is used as a cleaning solvent. MEK is a flammable material, and an irritant to workers.
  - MDMSC Recommendation. Another cleaning solvent may be used instead of the MEK. 1,1,1-Trichloroethane could be used as a replacement because it is nonflammable, thus less hazardous than MEK. This recommendation would need to be studied further to determine if this solvent would clean WR-ALC's parts to the

standards. Other studies are currently being performed by AFLC to evaluate substitute solvents which are less hazardous than MEK or 1,1,1-trichloroethane, which may be substituted after further study.

- Provide Better/Larger/Cleaner Toilet Facility for Women Mechanics - Building 603
  - Current Condition: The women's toilet in Building 603 has only one commode for six to eight women to use. Water stands in the general area of the toilet when it rains. The women have to go to adjacent buildings or wait.
  - MDMSC Recommendation: Provide better equipped and more sanitary toilet facilities.

General Area Improvement Opportunities

- Use Lockheed "Status" to Determine Drawing Changes and Effectivity
  - Current Condition: There seems to be a bit of confusion at WR-ALC as to how to determine the effectivity of a part or of a drawing revision. This is especially pertinent to the drawings and parts for the Lockheed C-130 and C-141 aircraft. When the Air Force bought these airplanes from Lockheed, they also bought the drawings and the drawing submittal system, which would be in accordance with the applicable MIL specification for the drawing requirements.
  - MDMSC Recommendation: A phone call to "Status" at Lockheed could get an answer whenever a problem arises involving whether a C-130/C-141 part is required on a particular model or not. "Status" could also be used to verify the latest drawing revision or Engineering Order change to a drawing.
- Move F-15 Canopy Repair Effort out of Building 670 to Larger Facility
  - Current Condition: The F-15 canopy repair effort occupies only a small portion of Building 670 and the repair effort does not have sufficient space.

- MDMSC Recommendation: Additional space is currently needed for canopy repair. The F-15 canopy should be moved to an area closer to the sheet metal repair, Building 169. As an additional observation, there is no grid board available to check the optical qualities of the transparencies when scratches are buffed out and the surface distorted.

• Remove Unused C-130 Leading Edge Jigs out of Building 603
  - Current Condition: Space is at a premium in Building 603. There are several unused C-130 leading edge jigs stored in Building 603 that are occupying much needed space. Four to six additional nozzle stations could be set up if this space were cleared out.
  - MDMSC Recommendation: Remove these jigs from the building; which would allow the C-141 nozzle effort to be expanded as planned.

Operational Improvement Opportunities

• Review/Allocate Sufficient/Dedicated Work Space for Each Workstation
  - Current Condition: There is much confusion now in certain areas because of the lack of dedicated and sufficient space for the mechanic and the work he/she is required to do. Traffic cross flow is bad and in some instances, there is no assigned or dedicated work space for the mechanic to do his/her assigned task. Observation of several areas in Building 169, such as the areas for the petal doors and ailerons for the C-141, led to this conclusion.
  - MDMSC Recommendation: The work space for a given repair task must be adequate to allow the work to be performed in the most timely and cost effective manner. Each work station must be designed and space allotted to allow the mechanic to do his/her assigned task without interruption from people passing by, cross flow traffic from fellow workers, insufficient space and confusion. MDMSC recommends, as a stop gap measure before an in-depth facilities layout can be made, that each work station be identified and permanently marked so that the mechanics assigned to that work station may work with a minimum of interruptions. Rails or fences should be considered to outline the stations.

Management Improvement Opportunities

- Put More Emphasis on QP4
  - Current Condition: Some RCC repair units do not have an active QP4 team. Those that do are not allotted the necessary time to be effective. Manpower seems to be a problem.
  - MDMSC Recommendation: Long standing complicated problems have a greater chance of being solved when a QP4 team is active in the area. More emphasis should be placed on the QP4 team effort and to give these groups greater visibility and recognition as problem solvers. The QP4 teams are currently being revised and restructured. It is suggested that more recognition and prestige be given the group.
- Include the Supervisor When Decisions are Made Affecting Quality/Production
  - Current Condition: Decisions are made sometimes that affect the production effort or the quality of a repair unit without the supervisor being told or asked to participate in the decision making process.
  - MDMSC Recommendation: Better solutions to MANPS problems may be realized so that when a task force is formed, it is formed from individuals most knowledgeable and intimately concerned with a solution to the problem, such as the production supervisor if the problem involves the production effort; or the tooling expert if the problem involves a tool change; or the planner if any change is contemplated in the work sequence or planning. The task force should always be headed up by the production supervisor if the problem involves production or quality.

Process Capability Opportunities

- Utilize the Planning Section for Help for All Manufacturing Coordination
  - Current Condition: When the manufacturing people (mechanics) have problems pertaining to the engineering and other data requirements for a particular unit being repaired they usually directly contact the technical support people, such as the manufacturing, tooling, facilities, or materials engineer. Usually the mechanics are not as well versed as the planner as to the overall part requirement

and design intent and consequently should take the problem through the planner for him to make the contact.

- MDMSC Recommendation: Make better use of the planning section to help solve all problems involving the technical implementation of the WCD. When the planner is contacted, he will be in a better position to: 1) Assist the mechanic to prevent work stoppages, 2) Revise the WCD, when required, 3) Coordinate the production effort, 4) Influence the standard hour requirement, and 5) Help solve tooling problems and requirements.

• Utilize the Quality Section for Help for All Repair Problems Involving Quality

- Current Condition: The supervisors and their designees often do not call the quality assurance specialist to help solve problems arising from the repair effort.
- MDMSC Recommendation: The quality assurance specialist should be utilized by issuing a Request for Quality Assistance (RQA) (AFLC Form 354). The quality assurance specialist will use the skills and facilities available to develop valid solutions or recommendations on all RQAs. Examples include, Quality Engineering, Methods Improvement Laboratory, Chemical or Materials Laboratories, and subject matter specialists from other divisions or directorates. All corrective actions will be thoroughly coordinated with all activities having a primary or collateral responsibility. Time will be reduced and/or work efficiency will be increased and as a result, the production rate increased.

Technology Improvement Opportunities

• Need Window Area Plot for F-15 Radome Repair Use

- Current Condition: There are approximately 150 F-15 radomes in an "X" condition (a condition of maximum damage) which will require a maximum effort to repair in the near future for MANPSD (Building 670). The F-15 repair Technical Orders do not give a "stay out" or "window" area for the radome to help guide the repair. Other Technical Orders, such as for the C-130 radomes, give this

information to establish repair limitations and help guide the mechanic making the repair. In the event the repair limits are not defined, it is probable that radomes will be repaired and not be usable, thereby wasting time, money, and effort.

- MDMSC Recommendation: There is a need to establish the repair limitations for the F-15 radomes. Hugh Darsey, (6) 5374, MMFRB, Cognizant Engineer is working with the test range (Building 675) people to derive information to define the repair limitations.

• Make Available to All ALCs' Paul C. Bevan's Fiberglass Repair Method

- Current Condition: The fiberglass repair process currently being used to repair F-15 radomes in Building 670 at WR-ALC is described in section 11 Development of Quick Fixes, of the MANPSD DDB. This repair process uses a tool called a "Patch-Puller-Ring" and appears to work satisfactorily.
- MDMSC Recommendation: MDMSC recommends that this entire process and repair technique be made available to all Department of Defense potential users for their evaluation or use.

TECHNOLOGY INSERTION-ENGINEERING SERVICES
PROCESS CHARACTERIZATION
TASK ORDER NO. 1

VOLUME VII
WR-ALC

QUICK FIX PLAN
25 SEPTEMBER 1989

CONTRACT NO. F33600-88-D-0567
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LIST OF ACRONYMS AND ABBREVIATIONS

AGMC	AEROSPACE GUIDANCE AND METROLOGY CENTER
DDB	DATABASE DOCUMENTATION BOOK
MDMSC	MCDONNELL DOUGLAS MISSILE SYSTEMS COMPANY
MTBF	MEAN TIME BETWEEN FAILURES
MTTR	MEAN TIME TO REPAIR
PCN	PART CONTROL NUMBER
RCC	RESOURCE CONTROL CENTER
TI-ES	TECHNOLOGY INSERTION-ENGINEERING SERVICES
WCD	WORK CONTROL DOCUMENT
WIP	WORK IN PROCESS
WR-ALC	WARNER ROBINS AIR LOGISTICS CENTER

WR-ALC QUICK FIX PLAN

10.0 WARNER ROBINS AIR LOGISTICS CENTER (WR-ALC)

During the third quarter 1989, McDonnell Douglas Missile Systems Company (MDMSC) completed process characterization of seven Resource Control Centers (RCCs) at WR-ALC in Warner Robins, Georgia. The process characterization was performed as a part of the Technology Insertion-Engineering Services (TI-ES) Program. The paragraphs which follow present recommendations to repair processes noted during the conduct of the TI-ES Program and are limited to improvement opportunities defined as quick fixes. A table of contents is included to facilitate the reader's search for material while Table 10.0-1 identifies the RCC applicability for each quick fix by paragraph number.

The seven RCCs characterized and modeled are in the Industrial Products Division (MAN) and consist of three MANPG Gyro Section Units and four MANPS Sheet Metal Units.

There are three MANPG RCCs responsible for aircraft navigational gyroscopes repair. They are MANPGA, responsible primarily for repair of miniature rate gyros, MANPGB, responsible for various vertical, two axis displacement gyros repair and flight data instruments, and MANPGC, responsible for directional gyroscope systems and rate switching gyros. There is close interaction and interdependence between these MANPG section RCCs.

The eight quick fixes applicable to RCCs MANPGA, MANPGB and MANPGC are summarized below with their respective estimated cost savings.

- Eliminate Clean Room Garb Requirements In MANPGA proposes that an evaluation of Technical Order requirements may determine the feasibility to eliminate non-productive Class 100,000 clean room "suits" for most, if not all, personnel working within the RCC. Yearly savings of $436,977 may be realized.

QUICK FIX APPLICABILITY MATRIX
TABLE 10.0-1 (SHEET 1 OF 2)

QUICK FIX TITLE	SCOPE (RCC AFFECTED)						
	MANPGA	MANPGB	MANPGC	MANPSA	MANPSB	MANPSC	MANPSD
CLEAN ROOM GARB	10.1.1						
VENT VACUUM PUMPS	10.1.2						
GIMBAL/SPIN BEARING HANDLING	10.1.3	10.2.3	10.3.2				
INDUCTION MACHINE	10.1.4	10.2.4	10.3.3				
DIAGNOSTIC CHECKS ON GYROS	10.1.5	10.2.5	10.3.4				
PCN 20012A TAPES		10.2.1					
RELOCATE MASS SPECTROMETER		10.2.2					
RANDOM DRIFT DECISIONS			10.3.1				
MECHANICS REPAIR HANDBOOKS				10.4.1	10.5.1	10.6.1	10.7.3
MECHANICS OWN HAND TOOLS				10.4.2	10.5.2	10.6.2	10.7.4
BOND MECHANICS RELOCATION				10.4.3			
AILERON HOLDING FIXTURE				10.4.4			
PICTORIAL WORKBOOKS (WCDs)				10.4.9	10.5.3	10.6.3	10.7.5
AILERON TAB HINGE LOCATER				10.4.5			
NEWSPAPER CLIPPING CUTTER				10.4.6			
OHMMETER/BRAZING CERTIFY				10.4.7			

QUICK FIX APPLICABILITY MATRIX
TABLE 10.0-1 (SHEET 2 OF 2)

QUICK FIX TITLE	SCOPE (RCC AFFECTED)						
	MANPGA	MANPBG	MANPGC	MANPSA	MANPSB	MANPSC	MANPSD
RADOME HOLDING FIXTURES							10.7.1
BRUSH ALODINE, BUILDING 603							10.7.2
COWL DOOR				10.4.8			
COBALT DRILL BITS				10.4.10	10.5.4	10.6.4	10.7.6

- Vent the Vacuum Pumps of the Mass Spectrometers in MANPGA is aimed at improving throughput of gyro leak checking operations by modifying the exhaust venting and utilizing currently available equipment resources. Yearly savings of $101,152 may be realized.

- Improve Gimbal/Spin Bearing Handling in MANPGA, MANPGB and MANPGC proposes establishing better material handling techniques to increase the yield of bearing refurbishment operations. Yearly savings of $6,600 may be realized.

- Improve Fixturing the Induction Machines in MANPGA, MANPGB and MANPGC proposes how safety and product quality improvements can be derived from a consistent fixturing methodology for gyro desoldering activities. Yearly savings of $39,266 may be realized after implementation.

- Re-evaluate Need for Diagnostic Checks at All MANPG RCCs proposes that based on historical E046B data, when wheel repair occurrence factors of 90% and greater are noted, a cost benefit can be derived by eliminating the limited value diagnostic testing for certain gyroscopes. Yearly savings for the 74146A gyro alone could be $4,191.

- Improve Bonding of PCN 20012A Tapes in MANPGB proposes that the acquisition of a thermo-compression bonder could allow rebonding of separated, undamaged tape which is currently scrapped. Yearly savings of $40,244 may be realized.

- Relocate Mass Spectrometers in MANPGB should eliminate nonproductive transit times away from the gyro seal repair area. Current concerns of potential air contamination by the mass spectrometers could be solved by improved ventilation and/or duct work if necessary. Yearly savings of $11,977 may be realized.

- Improve Random Drift Decisions in MANPGC proposes implementation of a decision panel device which should minimize the testing of defective gyros for a prolonged time. Yearly savings of $11,519 may be realized after implementation.

There are four MANPS RCCs responsible for repair of major sheet metal component assemblies for the C-130, C-141 and the F-15 aircraft. They are:

- MANPSA, responsible for the sheet metal bonding repair of the C-141 petal doors, access doors, ailerons, wing leading edges, horizontal stabilizer leading edges and the composite repair of the F-15 speed brake.

- MANPSB, responsible for the manufacture of new parts required for repair by other RCCs to support the C-130, C-141 and the F-15 repair effort.

- MANPSC, responsible for the bonding and conventional sheet metal repair of the C-130 elevator, flaps cowl scoop, the C-141 aft cowling and thrust door.

- MANPSD, responsible for the conventional sheet metal, fiberglass, bonded honeycomb, and composite repairs of the F-15A/F-15B canopies, F-15 radome, C-130E/C-130A radomes, C-141 engine exhaust nozzle and the C-141 wing leading edges.

The 12 quick fixes applicable to RCCs MANPSA, MANPSB, MANPSC, and MANPSD are summarized below with their respective estimated cost savings.

- Develop a Mechanic's Handbook for Each Repaired Assembly which would compliment and supplement the Technical Orders and document all major steps and techniques of each repaired assembly unit. The manual would be invaluable to new or less experienced mechanics in a rapid build-up surge or war-time readiness situation or where a

production rate increase would be necessary such as the present F-15 wing repair effort. Yearly savings of $1,598,706 may be realized, as shown in Table 10.4.1-1.

- Implement Program for the Mechanic to Buy and Maintain Own Hand Tools to eliminate/reduce the number of tools/boxes/stands, tool crib manpower and purchasing expense. The plan will provide the necessary tools to work with and make the worker responsible for the tool inventory and the replacement of broken hand tools. Yearly savings of $476,679 may be realized, as shown in Table 10.4.2-1.

- Move Bond Mechanics Closer to the Autoclaves, thereby reducing time lost by going back and forth to the mechanics home station. Yearly savings of $57,730 may be realized.

- Provide Level Aileron Support Tables to eliminate the time needed to make existing tables level. Yearly savings of $2,008 may be realized.

- Provide Pictorial Drawings With the Existing Workbooks (WCDs) to assist the worker to better understand the required task and to help train others in a surge or war-time emergency situation. Yearly savings for this quick fix are included in the Mechanic's Handbook Quick Fix.

- Design/Build An Aileron Tab Hinge Locator to aid the mechanic in the replacement and correctly shimming of the aileron tab hinge fittings on the C-141 aileron rear beam. This is difficult to do using the tab assembly as a tool because the tab leading edge is in the way. Yearly savings of $15,963 may be realized.

- Design/Build a Type of a Newspaper Clipping Cutter for the mechanic to use to assist the cutting of thin (.005) skins on the C-141 horizontal stabilizer leading edges. This tool is also similar to a tool used to cut wood veneers. This new tool will replace the current cumbersome way of

having to use unwieldy type makeshift tools such as a can opener. Yearly savings of $15,173 may be realized.

- Certify the Mechanic Repairing the C-141 Horizontal Stabilizer leading edges for the use of an ohmmeter and brazing units to check the continuity of the wiring and the mesh heating elements. This will relieve the mechanic from making at least four trips to the back shop for repair verification. Yearly savings of $60,691 may be realized.

- Provide Holding/Support Fixtures for All Radomes to hold the radomes on its side and to allow the radome to be rotated. This method would be similar to the holding fixture currently being used on the C-141 nozzle repair effort. This new support stand will provide better access and less worker strain. Yearly savings of $248,075 may be realized.

- Brush Alodine Treatment Capability for Building 603 to eliminate the transportation of parts to Building 180 about two miles away. This is currently under study for both a temporary and a permanent solution to the situation. (Existing study-no cost savings available).

- Combine Repair Operations for the C-141 Aft Cowl Door to complete the entire repair/rework effort in one work area rather than the current three. This will eliminate duplicity of effort and decrease the flow time for the unit by the amount of time required to move from one mechanic to another (not quantifiable).

- Make Available Cobalt-Tipped Drill Bits, or Equivalent, in lieu of resharpened drill bits, for the mechanic's use to drill out aluminum rivets and other type fasteners such as steel bolts and blind steel rivets. Yearly savings of $476,679 may be realized.

AFLC may realize an estimated $3,678,424 in recurring savings if all of the quick fix plan opportunities are incorporated as illustrated in Table 10.0-2.

WR-ALC QUICK FIX RECOMMENDATION SUMMARY

TABLE 10.0-2 (SHEET 1 OF 2)

MDMSC RECOMMENDATION	IMPACT	ANNUAL BUDGET SAVINGS	COST AVOIDANCE			INVESTMENT COST
			FLOW TIME REDUCTION	WIP INVENTORY REDUCTION*	FLOOR SPACE REDUCTION	
DEVELOP MECHANICS HANDBOOK (MANPSA, PSB, PSC, PSD)	DIRECT LABOR SAVINGS	$1,598,706	0 DAYS	$ 0	0 SQ. FT.	$ 28,000
PROVIDE PICTORIAL DRAWINGS IN WCDS (MANPSA, PSB, PSC, PSD)	DIRECT LABOR SAVINGS	INCLUDED IN ABOVE	0 DAYS	$ 0	0 SQ. FT.	$ 20,000
MECHANICS TOOL SET (MANPSA, PSB, PSC, PSD)	DIRECT LABOR SAVINGS	$ 476,679	0 DAYS	$ 0	981 SQ. FT.	$ 95,336
COBALT-TIPPED DRILL BITS (MANPSA, PSB, PSC, PSD)	DIRECT LABOR SAVINGS	$ 476,679	0 DAYS	$ 0	0 SQ. FT.	$ 10,000
ELIMINATE CLEAN ROOM GARB (MANPGA)	DIRECT LABOR SAVINGS	$ 436,977	0 DAYS	$ 0	0 SQ. FT.	$ 16,600
RADOME SUPPORT FIXTURE (MANPSD)	DIRECT LABOR SAVINGS	$ 248,075	0 DAYS	$ 0	0 SQ. FT.	$ 40,000
VENT MASS SPECTROMETERS (MANPGA)	DIRECT LABOR SAVINGS & ENVIRONMENTAL IMPROVEMENT	$ 101,152	0 DAYS	$ 0	0 SQ. FT.	$ 4,000
CERTIFY BRAZING MECHANIC (MANPSA)	DIRECT LABOR SAVINGS & INVENTORY REDUCTION	$ 60,691	UNDERWAY	-	-	UNDERWAY
RELOCATE BOND MECHANICS (MANPSA)	DIRECT LABOR SAVINGS	$ 57,530	0 DAYS	$ 0	0 SQ. FT.	NEGLIGIBLE
IMPROVE TAPE REBONDING (MANPGB)	DIRECT LABOR SAVINGS	$ 40,244	0 DAYS	$ 0	0 SQ. FT.	$ 2,562
TOTALS						

NOTES: * WIP INVENTORY REDUCTION = $\frac{\text{\# OF FLOW DAYS REDUCED}}{\text{365DAYS}}$ X (ASSET $ VALUE) X (YEARLY PRODUCTION RATE)

LSC-20607

WR-ALC QUICK FIX RECOMMENDATION SUMMARY

TABLE 10.0-2 (SHEET 2 OF 2)

MDMSC RECOMMENDATION	IMPACT	ANNUAL BUDGET SAVINGS	COST AVOIDANCE			INVESTMENT COST
			FLOW TIME REDUCTION	WIP INVENTORY REDUCTION*	FLOOR SPACE REDUCTION	
FIXTURE INDUCTION MACHINE (MANPGA, PGB, PGC)	DIRECT LABOR SAVINGS	$ 39,266	0 DAYS	$ 0	0 SQ. FT.	$ 10,690
AILERON TAB HINGE LOCATOR TOOL (MANPSA)	DIRECT LABOR SAVINGS	$ 15,963	0 DAYS	$ 0	0 SQ. FT.	$ 7,500
NEWSPAPER CLIPPING CUTTER TOOL (MANPSA)	DIRECT LABOR SAVINGS	$ 15,173	0 DAYS	$ 0	0 SQ. FT.	$ 1,600
RELOCATE MASS SPECTROMETERS (MANPGB)	DIRECT LABOR SAVINGS & ENVIRONMENTAL IMPROVEMENT	$ 11,977	0 DAYS	$ 0	0 SQ. FT.	$ 3,759
IMPROVE DRIFT DECISIONS (MANPGC)	DIRECT LABOR SAVINGS	$ 11,519	0 DAYS	$ 0	0 SQ. FT.	$ 10,000
IMPROVE BEARING HANDLING (MANPGA, PGB, PGC)	MATERIAL SAVINGS	$ 6,600	0 DAYS	20% YIELD IMPROVEMENT	0 SQ. FT.	$ 5,264
RE-EVALUATE DIAGNOSTIC CHECKS (MANPGA, PGB, PGC)	DIRECT LABOR SAVINGS	$ 4,191	0 DAYS	$ 0	0 SQ. FT.	NEGLIGIBLE
PROVIDE LEVEL SUPPORT TABLES (MANPSA)	DIRECT LABOR SAVINGS	$ 2,008	0 DAYS	$ 0	0 SQ. FT.	$ 1,500
COMBINE AFT COWL REPAIR OPERATIONS (MANPSA)	DIRECT LABOR SAVINGS	N/Q	0 DAYS	$ 0	0 SQ. FT.	NEGLIGIBLE
ALODINE BRUSH CAPABILITY (MANPSD)	FLOW TIME REDUCTION	EXISTING ALC STUDY	0 DAYS	$ 0	0 SQ. FT.	NEGLIGIBLE
TOTALS		$3,678,424				$256,811

NOTES: * WIP INVENTORY REDUCTION = $\frac{\text{\# OF FLOW DAYS REDUCED}}{\text{365DAYS}}$ X (ASSET $ VALUE) X (YEARLY PRODUCTION RATE)

LSC-20607

10.1 MANPGA QUICK FIX OPPORTUNITIES

During the characterization of the MANPGA RCC, MDMSC noted several potential opportunities to improve the performance of the MANPGA repair operation.

This section develops and presents five quick fix opportunities to assist MANPGA in meeting its objectives. These five quick fixes are detailed in paragraphs 10.1.1 through 10.1.5.

The MANPGA FY 88 inductions per quarter for the four Part Control Numbers (PCNs) which were characterized by MDMSC at WR-ALC are shown in FY 88 Workload Table 10.1-1.

MANPGA GYRO SHOP FY 88 WORKLOAD
TABLE 10.1-1

REPRESENTATIVE GYRO FAMILY PCN	FY 88 INDUCTIONS				TOTALS
	1ST QTR	2ND QTR	3RD QTR	4TH QTR	
74010A	265	265	265	265	1060
74074A	131	91	14	24	260
74103A	219	122	122	122	585
74126A	347	347	347	347	1388

LSC-20326A

10.1.1 Quick Fix Opportunity to Eliminate Clean Room Garb Requirements in MANPGA

10.1.1.1 Description of Current Operations

MANPGA is designated a Class 100,000 Clean Room facility for the repair of gyros that require super clean environmental conditions. Full suits, capped

hoods and booties must be worn and in place prior to entering the lab areas. Air locks are used for entering or exiting the suiting up area.

10.1.1.2 Description of Current Process Problems

RCC MANPGA is designated as a Class 100,000 clean room to repair oil damped gyros. Gyros repaired at this RCC were built during the late 1950s and early 1960s. Gyros repaired at RCCs MANPGB and MANPGC are more critical in nature than the ones repaired at MANPGA. During our assessment of this RCC, it was observed that the Class 100,000 clean room requirement is inconsistent and eating and drinking were allowed.

10.1.1.3 Description of New Process

MDMSC recommends the following:

- Remove the requirement to wear full suits, hoods and booties in the clean room
- Replace air locks and dressing rooms with simple tack mats and shoe brush cleaners at lab entrances
- Assign critical operations to horizontal and/or vertical laminar flow booths to maintain a Class 100,000 or better environment at specified workstations
- Require the use of coat smocks to stress the continued importance of cleanliness
- Reduce dirty operations such as unsealing, resealing, and filling or restrict them to forced ventilation booths
- Re-instruct and enforce proper use of laminar flow booths for critical operations
- Forbid eating and drinking in the lab area and extend this ruling to MANPGB and MANPGC
- Reduce line storage and develop a cleaning schedule for every bench, cabinet, and floor area

10.1.1.4 Rationale Leading to Change

Observations of lab conditions, actual interviews with lab personnel, general knowledge of lab requirements through participation in the contamination control

working group of the Inertial Guidance Community indicate changes are required in the clean room area.

The present laminar flow booths are being misused. All are full of parts, tools, and personal items. The filter areas are posted with schedules, technical items, etc. All these items cause air flow restrictions and greatly reduce laminar flow bench effectiveness.

Less restrictive personnel movement will permit increased coverage by support functions like engineering and thus improve throughput.

10.1.1.5 Estimated Cost Savings

Current Operations

Approximately 72 technicians work in RCC MANPGA on a daily basis per manpower assessment profiles. The time required to suit up and unsuit was observed to be greater than 0.8 hour per employee per day. The "full suit" criteria costs 72 x 0.8 hour x 240 working days per year x $31.61/hour = $436,977 per annum.

Also, current clean room apparel laundry and procurement costs are considerable but unquantifiable at this time.

New Process

Immediate labor efficiency savings of $436,977 per year can be realized in eliminating the clean room dress code requirements on an RCC wide basis. Additional cost savings will be realized from elimination of laundry costs of suits, hoods, and booties as well as periodic replacement costs. Product improvement will be accomplished by a disciplined cleaning schedule that is not limited to dust count improvement. An intangible savings can be realized through improved product support by removing the reluctance of support personnel to enter the lab areas. Areas presently used for suiting up also will become available, but building construction and layout may limit its usability.

10.1.1.6 Implementation Cost/Schedule

Some front end costs may be experienced by MANPG administration to develop laminar flow booth disciplines and cleaning schedules, but these should be minimal and no adverse impact is expected on schedule.

Communication/Training of Organizational Changes	$15,000
Tack Mats (2)	600
Shoe Brush Cleaners (2)	1,000
Estimated one time costs	$16,600

The implementation schedule will be dependent on review of Technical Order requirements and possible reluctance of change. Aerospace Guidance and Metrology Center (AGMC) and private industry practices and their success rates should encourage acceptance.

10.1.2 Quick Fix Opportunity to Vent the Vacuum Pumps of the Mass Spectrometers in MANPGA

10.1.2.1 Description of Current Operations

Mass spectrometers called out for leak checking of CN74074A series gyros have been shutdown. The reason given is that the discharge from the rough vacuum pumps increases the dust count in the particulate specification levels. This action forces gyros to be hand carried approximately 200 feet to a mass spectrometer outside the area.

10.1.2.2 Description of Current Process Problems

Approximately 0.2 hours of nonproductive labor is added to each unit processed. Process flow is further interrupted by the requirement to unsuit and resuit in clean room garb. Some batching is attempted, but it is not planned.

10.1.2.3 Description of New Process

Return local mass spectrometers to operation. Leak check CN74074A series gyros on specified equipment with closed ventilation and/or filtering in place.

10.1.2.4 Rationale Leading to Change

Observation during characterization indicated that the discharged air was unacceptably high in dust count. With preventive maintenance, spectrometers could then be returned to operation within MANPGA allowing increased throughput.

10.1.2.5 Estimated Cost Savings

Current Operations

Collected operation profile data and actual observation indicates there is an opportunity to reduce transit time on units leak checked by a minimum of 0.2 hour per assembly. Approximately 3,200 units of the CN74074A family are processed each year.

Nonproductive labor costs of 3,200 x {0.2 hrs. transit time + .8 hr. (resuiting)} X $31.61 = $101,152/year.

New Process

By utilizing the local mass spectrometers in MANPGA, elimination of the 0.2 hour transit time and 0.8 hour "resuiting" time results thus saving $101,152 annually.

10.1.2.6 Implementation Cost/Schedule

Costs to vent the mass spectrometers would require less than 2 hours each x 2 units. Filtering, if required, could add an additional cost of $5,000 each plus an estimated $2,000 in material costs. Scheduling would not be adversely impacted.

10.1.3 Quick Fix Opportunity to Improve Gimbal/Spin Bearing Handling in MANPGA

10.1.3.1 Description of Current Operations

Bearings being removed from repairable gyroscope products are handled as non-reusable material. Little or no care is evident in the removal and/or storage of the bearings prior to attempts to refurbish.

10.1.3.2 Description of Current Process Problems

Bearings are being damaged during removal by processing operations, open line storage and piling in uncontrolled containers. Storage is accomplished in open tote boxes or plastic bags with many piled loosely on top of each other increasing the opportunity for damage.

10.1.3.3 Description of New Process

MDMSC recommends providing tote tray inserts that will identify the I.D. bore of the bearings and will allow vertical stacking in a manner to prevent contact of adjacent bearings. Further action is required in development of personnel training to instill importance of bearing handling during unit teardown. The use of the tote boxes should be continuous through bearing refurbishment and storage being discontinued only when bearing is defined as scrap.

10.1.3.4 Rationale Leading to Change

Both WR-ALC and AGMC are presently engaged in bearing refurbishment with varying degrees of success. If handling damage can be eliminated or reduced, refurbishment yields can be improved. The refurbishment procedures remove contaminants, but cannot correct physical damage to the bearings. The lack of proper handling of bearings was observed through all three MANPG gyro RCCs.

Gyroscope Mean Time Between Failures (MTBF) should improve by reducing the possibility of returning physically damaged bearings to product.

Human Factors Design Criteria

Re-establishment of importance of proper procedure of teardown on unit acceptance yields.

Generally, private industries use special bearing pullers during teardown. Tote box inserts are used to handle and store bearings expected to be salvaged and returned to stock.

10.1.3.5 Estimated Cost Savings

Current Operations

Actual line observations and interviews with RCC personnel suggests a yield improvement in refurbished bearings in excess of 20%. The improvement will give double fold savings by yielding more product per refurbishment cycle and reducing induction costs of additional new bearings.

New Process

Approximately 12,000 units are repaired in MANPG yearly. Assuming each contains an average of four precision ball bearings and half require refurbishment or replacement, 24,000 precision bearings would be available for consideration. Further, if half are replaced, 12,000 are committed to refurbishment. The expected 20% improvement would amount to 2,400 bearings reclaimed over present methods. Using $2.75 as an average cost per ABEC five ball bearing, $6,600/year savings is available. No additional labor is added because the refurbishment attempt is completed regardless.

10.1.3.6 Implementation Cost/Schedule

Some MANPG administrative costs will be incurred due to training of personnel and development of a family of tote box inserts. Schedule and performance will improve as availability of critical bearings improves from the higher reclamation yields. Implementation could be accomplished within three months.

Development of the tote box inserts equals 40.0 labor hours X $31.61/hour = $1,264. Approximately 200 tote box inserts at less than $20 each = $4,000. Estimated one time cost = $5,264.

10.1.4 Quick Fix Opportunity to Improve Fixturing the Induction Machine in MANPGA

10.1.4.1 Description of Current Operations

The unit or subassembly is held in some hand clamping device prior to activating the induction heater to heat the assembly until the solder flows. The assembly is then "struck" on a part of the machine to impact enough energy to the assembly to force it apart.

10.1.4.2 Description of Current Process Problems

The units or subassemblies are being subjected to uncontrolled heat and forces from impact which damage the units. The operation produces scrap and additional rework. Safety concerns include risks from burns due to falling parts and solder splashes.

10.1.4.3 Description of New Process

MDMSC recommends that a QP4 team list all operations of disassembly performed on the induction machine. A fixture should be designed and fabricated with clamping devices for the list of units/subassemblies that can apply a separating spring force across the solder joint being heated. The spring force will be variable to allow control for the various units/subassemblies. Staging will be incorporated to assure heating of the separable joint with minimal heating of the rest of the assembly. Such fixtures are used successfully in private industry.

10.1.4.4 Rationale Leading to Change

Many observations of the induction machine operations were made. Many of the parts from each of the three RCCs pass across it for disassembly operations. The forces are great enough to distort the parts. The heat is high enough to char the insulation and make the metallic parts cherry red, as observed during our study.

The proposed change would reduce the possibility of injury due to burns. It would also reduce the amount of solder fluxes used in this area.
Mean Time Between Failures (MTBF) and Mean Time To Repair (MTTR) of gyros should improve by eliminating structural changes in critical parts due to uncontrolled temperature and by reducing impact forces.

10.1.4.5 Estimated Cost Savings

Current Operations

Historical data does not quantify the rework/scrap occurrences caused by the current operation.

New Process

Labor savings will be realized in highly reduced unit/subassembly cleanup, rewiring and part replacement costs. Fixtured disassembly should eliminate disassembly damage, reduce cleanup time by 50% and eliminate rewiring due to heat damage. Fixturization of the induction machine will reduce required manhours by at least 0.10 hour. Annual cost savings equals 12,422 units/year X 0.1 hours saved/unit X $31.61 = $39,266. Additional tangible savings should also be obtained from increased MTBF from less structural stress.

10.1.4.6 Implementation Cost/Schedule

The following represents project cost estimate:

Product list preparation (80 hrs x $31.61/hr)=	$2,529
Fixture Design (100 hrs)	3,161
Fixture Fabrication (2 units x $2,500/unit)=	5,000
Estimated one time costs	$10,690

No adverse schedule impact will be seen. The fixtures will be added on to existing equipment, causing little machine time interruption.

10.1.5 Quick Fix Opportunity to Re-evaluate Need for Diagnostic Checks at All MANPG RCCs

10.1.5.1 Description of Current Operations

When a 74146A gyroscope is received, a complete incoming test (diagnostic check) is performed at a MANPG RCC and is torn down and repaired as required.

10.1.5.2 Description of Current Process Problems

Ninety percent of the units being repaired require complete teardown and rebuild of the gyro wheel. This 90% wheel repair factor was established through RCC interviews. The standards data sheets, E046B labor standard operation resource standard/method analysis, places the occurrence factor at 100%. With this high of a percentage of complete teardown history, diagnostic testing prior to repair is of limited value.

10.1.5.3 Description of New Process

When a gyro unit is received, instead of performing diagnostic testing, tear down through the wheel, rebuild and then perform final testing per Technical Orders.

10.1.5.4 Rationale Leading to Change

Since 90% of the units require teardown through the wheel, most failures identified other than wheel failure will be removed or changed by the teardown process. The failures that are not found will be identified through the normal buildup process. Further, the 10% that do not contain identifiable wheel failure probably contain wheels of limited remaining life.

The MTBF and MTTR should both be impacted in a positive manner with removal of early failures of the 10% figure for wheels not presently rebuilt. Note: The logic applied to this unit should be defined to develop a percentage number where the diagnostic test should be dropped and 100% wheel rebuild demanded for all of the gyros.

10.1.5.5 Estimated Cost Savings

Current Operations

Perform a complete diagnostic check before teardown operation.

0.5 hours/unit X 1,020 units/year X $31.61/hour = $16,121

New Process

Eliminate complete diagnostic test before teardown operation. Estimated savings by eliminating diagnostic test is 0.5 hours/unit. Additional rebuild effort will add approximately 3.7 hours/unit for 10% of product.

3.7 hours/unit X .1 X 1,020 units/year X $31.61/hour	=	$11,930
Yearly Savings	=	$4,191

10.1.5.6 Implementation Cost/Schedule

No cost to implement should be experienced.

10.2 MANPGB QUICK FIX OPPORTUNITIES

During characterization of the MANPGB RCC, MDMSC noted several potential opportunities to improve the performance of the MANPGB repair operation.

This section develops and presents five quick fix opportunities to assist MANPGB in meeting its objectives. These five quick fixes are detailed in paragraphs 10.2.1 through 10.2.5.

The MANPGB FY 88 inductions per quarter for the two Part Control Numbers (PCNs) which were characterized by MDMSC AT WR-ALC are shown in FY 88 workload Table 10.2-1.

MANPGB GYRO SHOP FY 88 WORKLOAD
TABLE 10.2-1

REPRESENTATIVE GYRO FAMILY PCN	FY 88 INDUCTIONS				TOTALS
	1ST QTR	2ND QTR	3RD QTR	4TH QTR	
74051A	975	966	921	927	3789
20012A	333	322	330	314	1299

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10.2.1 Quick Fix Opportunity to Improve Rebonding of PCN 20012A Tapes

10.2.1.1 Description of Current Operations

Tapes that have become unbonded in service or teardown are replaced with a new tape and the old tape is scrapped.

10.2.1.2 Description of Current Process Problems

The tapes that have become unbonded appear to be unnecessarily scrapped when a new bond could be accomplished.

10.2.1.3 Description of New Process

Remove parted tapes, clean, thermo-compression bond and reassemble into unit.

10.2.1.4 Rationale Leading to Change

From general knowledge of thermo-compression bonding and interviews with repair line supervisor, determination was made that the tapes are not damaged other than separating.

10.2.1.5 Estimated Cost Savings

Current Operations

Approximately 30% of the tapes are replaced with new ones. The present production rate for the 20012A family is approximately 1,300 rolls/year.

Cost of new tape is $104.77/roll. New tape cost/year = 1,300/year x 30% x $104.77 = $40,860/year.

New Process

Rebond the tapes with the use of thermo compression. Rebonding cost = 0.05 hours/roll x (30% x 1300) x $31.61 = $616/year.

Yearly Savings = $40,244

10.2.1.6 Implementation Cost/Schedule

The implementation cost of a thermo-compression bonder (Micro-Bonder) is approximately $2,500, plus 2.0 hours installation for a total of $2,562.

Schedule impact is dependent only on delivery of the bonder as it is a line addition.

10.2.2 Quick Fix Opportunity to Relocate Mass Spectrometers in MANPGB

10.2.2.1 Description of Current Operations

Units are solder sealed in the repair area, then hand carried to the mass spectrometer, leak checked and hand carried back to the repair area. The two areas are approximately 300 feet apart (reference MANPGB Database Documentation Book (DDB) provided under separate cover). The movement is made through other repair areas with the normal distractions that occur.

10.2.2.2 Description of Current Process Problems

Time is being wasted in nonproductive travel. Another problem may be exaggerated by the increased sensitivity of the mass spectrometer beyond the rate required to meet the product requirements.

10.2.2.3 Description of New Process

Seal units in the immediate repair area. Leak check in the repair area and continue unit work in the same area.

10.2.2.4 Rationale Leading to Change

Actual interview with RCC personnel revealed that the mass spectrometers had been placed in the remote area to reduce malfunction of the system due to air contamination in the repair area. If the contamination condition is real, it can be overcome with flushing mass spectrometers with uncontaminated air or with proper duct work. This approach is used in general industry where required.

10.2.2.5 Estimated Cost Savings

Current Operations

Nonproductive transit time of approximately 0.1 hour/unit is expended.

3789 units/year x 0.1 hour x $31.61 = $11,977

New Process

MDMSC recommends that the mass spectrometers be relocated in the repair area. Savings to be realized would be 0.1 hour/unit checked.

Yearly Savings = $11,977

10.2.2.6 Implementation Cost/Schedule

Implementation to move the three mass spectrometers would be 8.0 hours each or a total of 24 hours ($759). If an air flushing system proves necessary, an additional estimated $3,000 of total rearrangement cost would be required.

Total implementation costs are approximately $3,759.

10.2.3 Quick Fix Opportunity to Improve Gimbal/Spin Bearing Handling in MANPGB

This quick fix recommendation affects not only MANPGB, but its sister gyro repair RCCs, MANPGA and MANPGC. This opportunity, Improve Gimbal/Spin Bearing Handling, is already presented in detail under the Quick Fix Opportunity section for MANPGA, paragraph 10.1.3.

10.2.4 Quick Fix Opportunity to Improve Fixturing the Induction Machine in MANPGB

This quick fix recommendation affects not only MANPGB, but its sister gyro repair RCCs, MANPGA and MANPGC. This opportunity, Improve Fixturing the Induction Machine, is already presented in detail under the Quick Fix Opportunity section for MANPGA, paragraph 10.1.4.

10.2.5 Quick Fix Opportunity to Re-evaluate Need for Diagnostic Checks in MANPGB

This quick fix recommendation affects not only MANPGB, but its sister gyro repair RCCs, MANPGA and MANPGC. This opportunity, Re-evaluate Need for Diagnostic Checks, is already presented in detail under the Quick Fix Opportunity section for MANPGA, paragraph 10.1.5.

10.3 MANPGC QUICK FIX OPPORTUNITIES

During the characterization of the MANPGC RCC, MDMSC noted several potential opportunities to improve the performance of the MANPGC repair operation.

This section develops and presents four quick fix opportunities to assist MANPGC in meeting its objectives. These four quick fixes are detailed in paragraph 10.3.1 through 10.3.4.

The MANPGC FY 88 inductions per quarter for the six Part Control Numbers (PCNs) which were characterized by MDMSC at WR-ALC are shown in FY 88 workload Table 10.3-1.

MANPGC GYRO SHOP FY 88 WORKLOAD
TABLE 10.3-1

REPRESENTATIVE GYRO FAMILY PCN	FY 88 INDUCTIONS				TOTALS
	1ST QTR	2ND QTR	3RD QTR	4TH QTR	
06121A	149	149	149	149	596
74061A	343	343	343	343	1372
74063A	244	244	244	244	976
74146A	255	255	255	255	1020
74148A	175	175	175	175	700
74149A	169	169	169	169	676

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10.3.1 Quick Fix Opportunity to Improve Random Drift Decisions at MANPGC

10.3.1.1 Description of Current Operations

After the gyros are sealed, they are placed on Scorsby Tables and connected to the test panel. The unit's heading is automatically printed out each half hour. One to twenty units can be tested at any time. An operator periodically enters the room and observes each unit's drift trend. As a unit deviates from specification, the readings are calculated for trending. At some point, trending units are rejected, removed from test, and sent to the sealing room along with test data to be opened and adjusted. The unit is adjusted, resealed, and returned to the Scorsby Tables, and the test process is restarted. This procedure is repeated until the unit passes the eight hour test or is classified as a hard failure.

10.3.1.2 Description of Current Process Problems

The rejection rate for first and second attempts appears to be 30%. From limited data 30% appeared to continue into the third and fourth attempt. The decision to readjust does not seem to be bounded either by amount of trending or length of run time. The units are unsealed and adjusted on the second shift only and this may account for the looseness in decision timing. It does not appear to be controlled well enough to assure a consistent product.

10.3.1.3 Description of New Process

MDMSC recommends incorporating a decision device into the panel to plot trending and automatically discontinue test at time of failure. Also recommend adding a vented solder station and fill manifold to the test area to allow for immediate readjust and return to test. Use the operator who presently observes and plots the trending to increase the productivity.

10.3.1.4 Rationale Leading to Change

Discussions with the test personnel and review of available test data lead to the opinion that the control does not assure a consistent product. It also lead to the conclusion that product flow could be improved if adjustments could be made at the test site.

The approach generally taken by private industry in this type of testing is to tightly describe the acceptance values and allow for automatic rejection at the earliest point. This allows for minimizing false testing time and the quickest return to productive work. This approach improves throughput and reduces flow time.

10.3.1.5 Estimated Cost Savings

Current Operations

Mechanic periodically observes the drift trend at his own convenience.
3,644 units/ year x .1 hour transit time x $31.61/hour = $11,519

New Process

Implementation of decision panel will minimize the testing of defective gyros for a prolonged time. Based on 30% rejection and savings of at least two hours of test time per gyro will provide about 800 hours of extra testing time per quarter. Transit time and queue time can be minimized.

The following can also be accomplished:

- Elimination of mode time and queue times waiting for second shift operator.
- Development of adjustment expertise from cause and effect relationship.
- Efficient usage of testers time.
- Consistent rejection/acceptance decisions.

Yearly Savings = $11,519

10.3.1.6 Implementation Cost/Schedule

Costs to be incurred would be the addition of a go/no go device on the present panel plus installation costs of a vented solder station and fill manifold.

Engineering estimates approximately $10,000 in implementation costs. There would be no adverse impact on schedule.

10.3.2 Quick Fix Opportunity to Improve Gimbal/Spin Bearing Handling in MANPGC

This quick fix recommendation affects not only MANPGC, but its sister gyro repair RCCs, MANPGA and MANPGB. This opportunity, Improve Gimbal/Spin Bearing Handling, is already presented in detail under the Quick Fix Opportunity section for MANPGA, paragraph 10.1.3.

10.3.3 Quick Fix Opportunity to Improve Fixturing the Induction Machine in MANPGC

This quick fix recommendation affects not only MANPGC, but its sister gyro repair RCCs, MANPGA and MANPGB. This opportunity, Improve Fixturing the Induction Machine, is already presented in detail under the Quick Fix Opportunity section for MANPGA, paragraph 10.1.4.

10.3.4 Quick Fix Opportunity to Re-evaluate Need for Diagnostic Checks in MANPGC

This quick fix recommendation affects not only MANPGC, but its sister gyro repair RCCs, MANPGA and MANPGB. This opportunity, Re-evaluate Need for Diagnostic Checks, is already presented in detail under the Quick Fix Opportunity section for MANPGA, paragraph 10.1.5.

10.4 MANPSA QUICK FIX OPPORTUNITIES

During the characterization of the MANPSA RCC, MDMSC noted several potential opportunities to improve the performance of the MANPSA repair operation.

This section develops and presents ten quick fix opportunities to assist MANPSA in meeting its objectives.

The MANPSA FY 88 inductions per quarter for the six PCNs which were characterized by MDMSC at WR-ALC are shown in FY 88 Workload Table 10.4-1.

MANPSA SHEET METAL SHOP FY 88 WORKLOAD
TABLE 10.4-1

PART CONTROL NUMBER (PCN)	FY 88 INDUCTIONS				TOTALS
	1ST QTR	2ND QTR	3RD QTR	4TH QTR	
01900A	6	11	20	11	48
05502A	17	15	22	23	77
51334A	0	3	3	5	11
51352A	74	26	54	26	180
51418A	10	13	13	8	44
51454A	8	9	8	10	35

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10.4.1 Quick Fix Opportunity to Develop a Mechanic's "Handbook" for Each Repaired Assembly

10.4.1.1 Description of Current Operations

Most of the mechanic's training is now received from actual work performed on a particular unit while being supervised by a more experienced worker.

Since there are no handbooks available to instruct teardown, inspect and repair of an assembly, most experienced mechanics have prepared written notes to help guide them in the repair effort.

10.4.1.2 Description of Current Process Problems

Certain peculiarities in the rework process require a knowledge far above what the Technical Order and Work Control Document (WCD) instructions provide. The WCD frequently does not provide the repair sequence that would enable the most efficient repair of an assembly.

10.4.1.3 Description of New Process

MDMSC recommends compiling and publishing a mechanic's training handbook for each assembly being repaired in MANPS. The manual would compliment and supplement the Technical Orders and be compiled by training specialists using the experiences and inputs of the top mechanics currently doing the repair work. The training manual would be initiated to recognize the subtleties of the repair process and would document all major steps and techniques of each repaired assembly unit. The manual would be coordinated through the training monitor and the cognizant process engineer, manufacturing engineer, planner, production supervisor and quality people and will require an expansion of their present job assignments.

During process characterization of MANPSA, observations indicated a training device for new people would be an asset to the RCC. In a rapid build-up required from a surge or war-time readiness situation, any crisis such as the present mechanics "turn-around" due to the F-15 wing effort or where a production rate increase would be necessary, handbooks would be an invaluable tool. Additional training and motivational courses would also benefit from the "Handbooks."

10.4.1.4 Rationale Leading to Change

During the characterization of several PCNs in the sheet metal repair RCCs at WR-ALC it was determined that the mechanics were not as familiar with the particular assembly being repaired or the Technical Orders and the Workbooks

(WCDs) as they should be. Some of the mechanics were new to the area and a few did not have sufficient experience to work alone and without a great deal of special guidance and instructions.

Some of the more experienced mechanics had made "crib sheets" to help them in their efforts and to help the newer mechanics to learn the job quicker. Some of these written notes and sketches had been handed down from the more senior mechanics who were transferred to the F-15 wing repair effort, for example.

It was decided by MDMSC that an official manual or "crib sheet" would be advantageous to the repair effort. A standard procedure in a handbook would ensure consistency in the repair operations and reduce training time.

10.4.1.5 Estimated Cost Savings

During process characterization of RCC MANPSA, as well as RCCs MANPSB, MANPSC and MANPSD, observations indicated considerable time was lost during repair operations by the mechanics due to the absence of good, easy-to-follow repair procedures.

An average increase in efficiency for experienced and new mechanics of 10% can be realized if clear, concise repair instructions are provided.

Table 10.4.1-1 provides the data depicting the savings which can be realized yearly by the individual RCCs.

10.4.1.6 Implementation Cost/Schedule

Cost of an existing training specialist to coordinate the inputs is estimated to be $20,000 per annum (pro-rated). Cost of preparing and reproducing each manual is estimated to be $20 per copy x 400 copies = $8,000. Implementation could be realized in about 60 days from "Go-Ahead." Total implementation costs would be an estimated $28,000.

MECHANICS REPAIR HANDBOOK COST SAVINGS SUMMARY
TABLE 10.4.1-1

SHEET METAL SECTION RCC	PARAGRAPH	ALC HOURLY RATE	COST SAVINGS PER YEAR*	ESTIMATED MANPOWER
MANPSA	10.4.9	$31.61	$275,639	50
MANPSB	10.5.3	$31.61	$341,793	62
MANPSC	10.6.3	$31.61	$485,125	88
MANPSD	10.7.5	$31.61	$496,151	90
TOTAL SAVINGS = $1,598,708				

* FORMULA: 0.10 X 1744 (MANHOURS PER YEAR) X NO. OF MECHANICS PER RCC X ALC HOURLY RATE = SAVINGS PER YEAR

NOTE: The cost savings shown represents the total savings from implementing 10.4.2 and 10.4.9 quick fixes

10.4.2 Quick Fix Opportunity to Implement Mechanics "Buy-Maintain" Tool-Set Program

10.4.2.1 Description of Current Operations

All sheet metal mechanics are issued a standard set of tools, a tool box and a tool stand with drawers. Some of the tools issued are never used; for example, the rivet guns issued have limited use. Neither the most widely used gun, (3 X type for 1/8" and 5/32" AD rivets) nor a 45 degree pneumatic angle drill attachment has been included in the set of tools.

10.4.2.2 Description of Current Process Problems

In some instances the replacement of a broken tool takes up to several weeks for replacement. In the interim, the mechanic either uses a "loaner" from the tool crib or borrows/shares a tool with a team member.

Large tool boxes and tool stands occupy much valuable space. Reducing the number of tools would save much space by requiring a smaller box or tool stands.

10.4.2.3 Description of New Process

Other repair facilities require the mechanics to buy and maintain their own set of tools. These companies establish the requirements for the tool set and assist the mechanics in selecting the manufacturers of the tools. Inferior quality items that do not hold up and which constantly require replacement are eliminated. The tool manufacturers most often offer a life-time guarantee and a substantial discount to the mechanic because of the volume purchases. This has proven to be cost effective in many instances, for maintenance facilities such as Eastern, Delta, Hayes and Lockheed Airservice.
One or two sets of "Limited-Use Tools" could be issued to an RCC repair area for general use.

Other fallout benefits would:

- Reduce the number of tools/tool boxes/tool box stands by 50% which would save much valuable and needed space.

- Eliminate/reduce tool crib manpower and storage area.
- Eliminate/reduce buying activity and expense.
- Provide the mechanic with the necessary tools to work with.
- Provide the mechanic with an expeditious way to replace broken tools.
- Make the mechanic responsible for the tools that he uses to perform his assigned tasks.

10.4.2.4 Rationale Leading to Change

During the characterization of the RCCs at WR-ALC, especially in the repair efforts in Buildings 169, 603 and 670, it became clear in the interviews with the mechanics that the hand tools provided to the mechanics were not adequate or sufficient for them to do a proper repair job.

Further interviews and investigations revealed that there was an abundance of tools issued to the mechanics that were rarely or never used. The tool box kits issued apparently are not tailored to the mechanics' real needs and required a tool box/stand much larger than necessary. Most work areas are limited in space and an oversized tool box/stand was not only occupying a significant part of the valuable work space but adversely affected the traffic flow within the work area.

The mechanics also pointed out that a replacement tool often took a long time to be replaced. Some of the necessary tools that they were using were not standard issue and some were obtained from retiring mechanics or from outside WR-ALC sources.

10.4.2.5 Estimated Cost Savings

Providing each mechanic with the proper tools to perform their assigned tasks would result in savings in time spent acquiring the correct tools upon task assignment and also in the storage area required.

Table 10.4.2-1 provides the data depicting the savings which can be realized by the MANPSA, MANPSB, MANPSC and MANPSD RCCs by providing the mechanic with the correct tools.

MECHANICS OWN TOOLS COST SAVINGS SUMMARY

TABLE 10.4.2-1

SHEET METAL SECTION RCC	PARAGRAPH	ALC HOURLY RATE	COST SAVINGS PER YEAR*	ESTIMATED MANPOWER
MANPSA	10.4.2	$31.61	$82,186	50
MANPSB	10.5.2	$31.61	$101,911	62
MANPSC	10.6.2	$31.61	$144,647	88
MANPSD	10.7.4	$31.61	$147,935	90
TOTAL SAVINGS = $476,679				

* FORMULA: 1.0 (MANHOUR SAVED PER MECH) X 52 WEEKS X NO. OF MECHANICS PER RCC X RCC HOURLY RATE = SAVINGS PER YEAR

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Observations made during RCC characterization also indicated a smaller area for tool storage would be required if only the proper tools were provided. An estimated three square feet per mechanic could be saved by reducing tools to only required tools.

Total square footage gained for each building would be approximately as follows:

BLDG	NO. MECHANICS	REDUCTION	AREA TOTAL	RCC
169	228	3	684 SQ FT	PSA, PSB, PSC
603 (605)	40	3	120 SQ FT	PSD
670	59	3	177 SQ FT	PSD

10.4.2.6 Implementation Cost/Schedule

The schedule, implementation cost, and selection of tool needs would vary with each RCC and tool suppliers. A ROM estimate would equal 20% of the expected annual savings, or $95,335.

10.4.3 Quick Fix Opportunity to Move Bond Mechanics Closer to the Autoclaves or Allow the Repair Group Close to the Autoclave to do the Bond Work

10.4.3.1 Description of Current Operations

There are approximately 14 frame and longeron assemblies for the C-141 Aileron which require rebonding when they undergo repair at MANPSA. There are also miscellaneous assembly units such as the approximately 12 C-141 petal door frames/longerons that require rebonding.

10.4.3.2 Description of Current Process Problems

The Aileron parts are rebuilt in W. Blackmon's area adjacent to the autoclave area and returned to S. William's control after completion, but the Petal Door parts are rebuilt in T. Cherry's area and then sent to rebond by the Petal Door

mechanic and returned to him after completion. This is not an efficient flow of work effort, due to the inconsistencies in the process flow.

10.4.3.3 Description of New Process

Move those three to four workers closer to the autoclave who work/repair small bonded assemblies such as the frame assemblies for the C-141 Petal Doors and the C-141 Aileron Leading Edges, thereby reducing travel time. (Always make the transit worker responsible to the supervisor who is responsible for the final inspection and buy-off of the unit being repaired.)

An alternative way to eliminate to and from travel by the mechanics would be to allow the repair group close to the autoclave to do all the bond work.

Centralizing the bonding of rebuilt assemblies would tend to:

- Eliminate wasted time and steps.
- Produce consistently better quality work.
- Have the bonding operation in a cleaner and better controlled environment.
- "Free" the "Home" mechanic to do more specialized work for which he is more qualified than others.

10.4.3.4 Rationale Leading to Change

While interviewing and observing the work process flow of several honeycomb assemblies in the bond repair shop in Building 169 it was noticed that time was being wasted and lost due to splitting up the repair operations between several different Building 169 work centers. In one case, the mechanic whose responsibility it was to ascertain the extent of damage and repair was not the mechanic to ultimately sign-off and approve the quality of the repair. In this same instance the mechanic made a more extensive repair than necessary to get overtime work.

Some of the areas where teardown is done is not environmentally controlled as is the staging area close to the autoclave. Not all of the mechanics in this staging area were certified as bond mechanics but an attempt was being made

to certify all. The bonding area adjacent to the autoclave was permitting grinding, sanding, etc. to be done next to workers preparing adhesive and bonding preparations. The contamination of the adhesive will cause bonding failures, so this operation should be done in a cleaner environment.

10.4.3.5 Estimated Cost Savings

It is estimated that a savings of 10 manhours per week could be realized. A saving of 10 manhours x $31.61 x 52 weeks x 3.5 men = $57,530 per year.

10.4.3.6 Implementation Cost/Schedule

The implementation cost will be negligible and existing scheduled inductions would not be adversely affected.

10.4.4 Quick Fix Opportunity to Provide Level Aileron Support Tables Until a Better Holding Fixture Can be Provided (MANPSA)

10.4.4.1 Description of Current Operations

The MANPSA RCC is responsible for skin, hinge, tab removal and leading edge work on C-141 Ailerons. Support tables for the C-141 Ailerons must be level before the work is performed.

10.4.4.2 Description of Current Process Problems

A work order will be issued in the near future by WR-ALC MANEE to make new level tables to support the C-141 ailerons.

10.4.4.3 Description of New Process

The recommended quick fix is to provide tables of the same height to support the ailerons until customized cradle-type holding fixtures are available.The customized cradles will support the ailerons and eliminate the "manhandling" and "flip-flopping" from side to side and also allow both sides and the beam/tab area to be worked simultaneously.

The quick fix recommendation results from the excessive time observed to level tables before work can be performed on the C-141 Ailerons.

10.4.4.4 Rationale Leading to Change

Observation in the aileron repair area of RCC MANPSA in Building 169 perceived a great deal of manhandling by the mechanics in the effort to obtain adequate access to affect the necessary repairs. The tables that are used for the work stands each had different type legs or rollers and were difficult to make level because the aileron required three tables to support the entire length of the aileron.

The time to level the table supports usually required two to three mechanics about 15 to 20 minutes time for each aileron. Observations were made that required more time than the normal amount of 15 to 20 minutes, some taking as long as 30 minutes.

10.4.4.5 Estimated Cost Savings

The level tables will save leveling time (usually 15-20 minutes) for 2-3 mechanics and eliminate overhanging of the aileron when tables are not available. Seventy-seven ailerons were inducted last year x 2.5 mechanics x .33 hours x $31.61/hour = $2,008 per year savings, approximately.

10.4.4.6 Implementation Cost/Schedule

The estimated cost of modifying the existing tables to provide permanent, level, support tables is $1,500. The work could be accomplished within 30 days.

10.4.5 Quick Fix Opportunity To Design/Build Aileron Tab Hinge Locator

10.4.5.1 Description of Current Operations

The MANPSA RCC is responsible for replacing tab hinge brackets on the C-141 Aileron.

10.4.5.2 Description of Current Process Problems

A tab hinge bracket has to be replaced on most of the aileron repairs and the aileron tab assembly is used as a tool to locate the bracket and bracket shim by

using the tab. This is difficult to do because the tab leading edge is in the way which makes it hard to position and locate the required shims behind the new fittings.

10.4.5.3 Description of New Process

The quick fix recommendation is to obtain a hinge locator and alignment tool needed to assist the replacement of an aileron tab hinge fitting on the C-141 aileron rear beam. A simple bar type locator tool would be sufficient and speed up the task.

Observation and interviews with the supervisor and several senior mechanics indicated the hinge bracket replacement is a tedious and time consuming task.

10.4.5.4 Rationale Leading to Change

The supervisor and his alternate were interviewed during the process characterization of the aileron RCC MANPSA and both expressed a desire to discuss their current problem with the replacement of the aileron tab hinges. After observation and discussion of the problem with several mechanics who were replacing the hinge fittings, it was mutually agreed that a better way could be found. The use of the tab as a hinge line fitting locator tool should be replaced by a tool expressly designed and made for that purpose. The tool could be left open in the hinge areas so the mechanic could see and have access to work.

10.4.5.5 Estimated Cost Savings

The hinge bracket replacement requires an average of ten manhours per aileron to replace the bad tab hinge fittings. This time would be reduced to approximately 1/2 of this or about five manhours with a bar-type locator tool. The annual savings estimates would be five manhours saved per aileron.

5 Hrs/aileron x 101 ailerons/Year x $31.61 = $15,963/Year.

10.4.5.6 Implementation Cost/Schedule

The cost of a simple bar-type tool would be the primary cost involved:

• Material Cost	$2,000
• Welding	500
• Machining	3,000
• Engineering	2,000

Note: Use average manhour cost of $50.00/hour

Total Ccst $7,500

10.4.6 Quick Fix Opportunity to Design/Build a "Newspaper Clipping Cutter" to Cut the Thin Skins on the C-141 Horizontal Stabilizer Leading Edges

10.4.6.1 Description of Current Operations

The thin .005 thick stainless steel cover skins for the C-141 Horizontal Stabilizer de-icer leading edge assemblies (eight per aircraft) must be removed in order to inspect and repair the embedded direct current wires and/or the heating elements.

10.4.6.2 Description of Current Process Problems

The current method of skin removal is to cut and peel the cover skins using a wood chisel, tin snips, pliers, etc. to remove the skin, without damaging the wires or the heating elements.

10.4.6.3 Description of New Process

The recommended quick fix is to design and make a depth cutter similar to the type cutter used to cut out newspaper clippings or to cut wood veneers. This type cutter may be set to cut at a predetermined depth so as to cut the (.005) stainless steel thin skin cover and not cut the wires or the heating elements.

This new method of skin removal would allow the old skins to be removed in an easier manner thereby saving time and producing a neater and a more professional repair job.

10.4.6.4 Rationale Leading to Change

While observing the mechanic's effort to teardown and remove the old skins from the C-14 horizontal leading edge sections, it was decided that a better way should be found. This current cumbersome way to remove the thin outer skin involves the use of makeshift tools such as modified screwdrivers, chisels and putty knife scrapers, etc.

It was concluded that a new easier method of skin removal should produce a neater, faster way and decrease flow time for the leading edge repair effort.

10.4.6.5 Estimated Cost Savings

A possible savings of two manhours per leading edge section should be realized: for a total of 8 sections x 2 = 16 manhours saved per aircraft. A total savings per annum of 16 manhours times $31.61, per hour (MANPSA), = $506 per aircraft = (15 A/C per annum for MISTR items plus 15 A/C per annum for PDM items) = 30 x $506 = $15,173/year.

10.4.6.6 Implementation Cost/Schedule

A veneer cutting tool that is used in the furniture industry usually sells for around $1,500 each. This type tool could be purchased and a new harder blade could be made for approximately the same dollar amount. The purchase of the ten sets of the tools plus blades and modification costs should not exceed $100. Implementation cost would be negligible and current schedules affected minimally.

10.4.7 Quick Fix Opportunity to Certify Mechanic Doing Repair Work on the Horizontal Stabilizer Leading Edges for "Ohmmeter" and "Brazing" use

10.4.7.1 Description of Current Operations

When a Horizontal Stabilizer is brought into the MANPSA RCC for repair, the mechanic uses an ohmmeter to check the continuity of the wiring on the C-141 Horizontal Stabilizer leading edge sections. These sections form an electrically

de-iced section of the horizontal stabilizer. All sections are repaired either by repairing the wires and/or welding breaks in the mesh.

10.4.7.2 Description of Current Process Problems

The mechanic has to use the back shop on four occasions for the use of the "Ohmmeter" or the "Welding Unit," usually making the trips herself, to verify the repair.

10.4.7.3 Description of New Process

In repairing the leading edge sections, the mechanic currently has to use an Ohmmeter to determine the repair so she should be certified for the Ohmmeter use as well as the use of the welding unit that is required to make the repairs to the mesh heating element.

Discussed with Sonny Heard, Training, the possibility of training/certification of Amanda Knight and others, if necessary, to the use of the Ohmmeter and the Welding/Brazing unit which would eliminate the back shop work and the related expense of the mechanic hand carrying the parts to and from the electrical building.

10.4.7.4 Rationale Leading to Change

It was observed during the characterization of the effort to repair the C-141 horizontal stabilizer leading edges that the mechanic was required to make several trips to another building to have an electrical repair mechanic check the continuity of the heating elements and wires that are used to heat the metal shell covering. This was unnecessary because the mechanic, on her own initiative, used an ohmmeter to first determine the extent of repair as well as to ascertain whether the repair was sufficient or not. It was concluded that this initiative type effort on the mechanic's part should be made an official part of the WCD and she should be trained, certified and permitted to do this job.

10.4.7.5 Estimated Cost Savings

The elimination of four back shop operations would save 4 times 2 manhours = 8 manhours per part; 8 parts times 8 manhours equals 64 manhours saved per

aircraft. Thirty aircraft (15 MISTR + 15 PDM = 30) x $31.61 per hour times 64 = $60,691 per annum equal saved.

10.4.7.6 Implementation Cost/Schedule

This quick fix opportunity has already been implemented for the mechanics use of the welding/brazing unit. The necessary steps to certify the mechanic for ohmmeter use is currently under way. The WCDs are in the process of being revised to reflect these changes.

10.4.8 Quick Fix Opportunity to Combine Repair Operations for the C-141 AFT Cowl Door to Use One Mechanic in Lieu of the Present Two

10.4.8.1 Description of Current Operations

The current way of reworking the C-141, Aft Cowl Door, is to have one mechanic teardown the old assembly and salvage the salvageable hardware and miscellaneous parts and another mechanic in another area to repair/rebuild the bonded honeycomb section of the door. (A third mechanic is also involved by removing the door from the cowl in another area.)

After the bonded section is completed, it is transported back to the "Teardown" area and reassembled by the first mechanic (who is not bond certified).

10.4.8.2 Description of Current Process Problems

The current way of repairing the doors has no obvious quality problems with the exception of completion responsibility, and the excessive amount of flow time required between workers.

10.4.8.3 Description of New Process

The recommended quick fix is to complete the entire operation of door repair in one area and not move the part back and forth from one area to another. The "Teardown" mechanic should be trained and certified for bond operations.

The new process will:

- Eliminate Duplicity of effort.
- Decrease "Flow-Time."
- Provide more trained workers.
- Provide more versatile workers.

10.4.8.4 Rationale Leading to Change

During the characterization of the C-141 aft cowl door it was necessary to interview three different mechanics to obtain a real insight to the process and flow of the door repair effort. Some particular operations such as damage determination was being done more than once. An excess amount of time was being spent to transport the door from one area to another area. No one mechanic would accept full responsibility for the entire repair job primarily because not all the mechanics working on the door had been to bond school.

10.4.8.5 Estimated Cost Savings

Flow time will be decreased at least by the time required for the part to flow between the areas which is usually four to six hours per door. Total flow time for processing will change from 108 to 102 hours.

By certifying all workers for bonding, a more versatile utilization of the worker is possible who in turn is more capable of training others.

At least one full time mechanic will be released for other work.

10.4.8.6 Implementation Cost/Schedule

This may be done immediately with little cost to implement.

10.4.9 Quick Fix Opportunity To Provide Pictorial - Drawings With the Existing "Workbooks" (WCDs)

10.4.9.1 Description of Current Operations

The current copies of the WCDs (workbooks) are difficult to read and hard to understand. (This is true industry-wide.)

10.4.9.2 Description of Current Process Problems

Mechanic personnel can not adequately use the WCDs for repair instructions.

10.4.9.3 Description of New Process

The production planner, with assistance from the WR-ALC Art Department, should provide a pictorial drawing, (exploded step-by-step drawing or otherwise), to accompany the "Workbook" (WCD) to assist the worker to better understand the task and to help train others in a surge or war time emergency situation.

The Mechanics would be more productive and understand what they are doing if better work instructions were available.

Most other repair facilities as well as as production manufacturing facilities are using pictorial drawings to supplement the Technical Order's and the planning sheets. Quality has, in most cases, improved considerably because the mechanics better understood what they were supposed to do.

10.4.9.4 Rationale Leading to Change

Interviews were conducted with several mechanics and their supervisors/alternates in the attempt to determine some method or approach that would assist the mechanics to better understand the workbooks (WCD).

The pictorial drawing approach to supplement the work step operations that is currently in use at most other repair and maintenance facilities was presented and discussed and it was concluded that this would be a logical approach to help the mechanics better understand their task assignments.

10.4.9.5 Estimated Cost Savings

It is estimated that a mechanic's efficiency would increase approximately 10% if the mechanic had a more comprehensive and understandable set of repair instructions to follow.

Table 10.4.9-1 provides the data depicting the savings which can be realized yearly by RCCs MANPSA, MANPSB, MANPSC and MANPSD.

10.4.9.6 Implementation Cost/Schedule

A full time illustrator to make the drawings would cost approximately $20,000 per year and could conceivably reduce the planning staff by a like number due to a reduction in contacts from manufacturing. An estimate of about 90 days to hire the necessary qualified illustrator and organize the effort would be required.

10.4.10 Quick Fix Opportunity to Make Available Cobalt-Tipped Drill Bits, or Equivalent, for Mechanic's Use for Drilling Out Fasteners

10.4.10.1 Description of Current Operations

The present lot of resharpened drill bits, especially the sizes normally used to drill out rivets and other type fasteners are not properly ground on center and the tips are softer than the normal quality of new drill bits.

10.4.10.2 Description of Current Process Problems

These off-center and soft bits wander off-center when the fastener is drilled out sometimes enlarging the hole and requiring a backing strip, or making necessary the installation of the next size larger salvage rivet for the enlarged hole.

10.4.10.3 Description of New Process

Provide the sheet metal mechanic with a better quality drill bit such as a Cobalt tipped bit, or equivalent, to be used on high-value assemblies when drilling out rivets and other type fasteners such as lock bolts or blind rivets and bolts.

The current quality of resharpened drill bits is extremely poor, contributing to oversize and nonconforming holes, causing unnecessary work and much time lost.

PICTORIAL WORKBOOKS (WCDS) COST SAVINGS SUMMARY
TABLE 10.4.9-1

SHEET METAL SECTION RCC	PARAGRAPH	ALC HOURLY RATE	COST SAVINGS PER YEAR*	ESTIMATED MANPOWER
MANPSA	10.4.9	$31.61	$275,639	50
MANPSB	10.5.3	$31.61	$341,793	62
MANPSC	10.6.3	$31.61	$485,125	88
MANPSD	10.7.5	$31.61	$496,151	90
TOTAL SAVINGS = $1,598,708				

* FORMULA: 0.10 X 1744 (MANHOURS PER YEAR) X NO. OF MECHANICS PER RCC X ALC HOURLY RATE = SAVINGS PER YEAR

NOTE: The cost savings shown represents the total savings from implementing 10.4.2 and 10.4.9 quick fixes

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10.4.10.4 Rationale Leading to Change

It was discovered very early in the process characterization of the sheet metal RCCs at WR-ALC that the current quality of resharpened drill bits was causing poor quality work. An observation was made of the drill bit wandering off center. This contributed to oversize and nonconforming holes which required an oversize, more expensive fastener or sometimes an extra back-up strip to reinforce the riveted joint.

It was found on one occasion that a large cache of these soft and undersize drill bits were stored and taken out of circulation in the effort to obtain better ones.

Some of the mechanics have bought their own bits or procured some harder ones from other work areas such as the F-15 wing repair effort.

10.4.10.5 Estimated Cost Savings

It is estimated that approximately one manhour is lost per RCC every week trying to make quality work with these inferior quality drill bits. It is also estimated that the cost of the desired drill bit is about twice the cost of the current resharpened ones. The resharpened bits last about 1/10 of the life of the cobalt-tipped variety providing they are put to use.

Some supervisors/mechanics check out an excess quantity of resharpened bits from tool supply in the attempt to find good ones. Some are better than others but overall the quality is inconsistent and poor. The rejected ones then are almost never returned to supply and in most cases are stored away or discarded.

Table 10.4.10-1 provides data depicting the savings which can be realized yearly by RCCs MANPSA, MANPSB, MANPSC and MANPSD.

10.4.10.6 Implementation Cost/Schedule

An engineering ROM estimate of $10,000 would enable an adequate supply of quality hardened drill bits.

COBALT DRILL BITS COST SAVINGS SUMMARY

TABLE 10.4.10-1

SHEET METAL SECTION RCC	PARAGRAPH	ALC HOURLY RATE	COST SAVINGS PER YEAR*	ESTIMATED MANPOWER
MANPSA	10.4.10	$31.61	$82,186	50
MANPSB	10.5.4	$31.61	$101,911	62
MANPSC	10.6.4	$31.61	$144,647	88
MANPSD	10.7.4	$31.61	$147,935	90
TOTAL SAVINGS = $476,679				

* FORMULA: 1.0 (MANHOUR SAVED PER MECH) X 52 WEEKS X NO. OF MECHANICS PER RCC X ALC HOURLY RATE = SAVINGS PER YEAR

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10.5 MANPSB QUICK FIX OPPORTUNITIES

During the characterization of the MANPSB RCC, MDMSC noted several potential opportunities to improve the performance of the MANPSB repair operation.

This section develops and presents four quick fix opportunities to assist MANPSB in meeting its objectives.

The MANPSB FY 88 inductions per quarter for the 15 Part Control Numbers (PCNs) which were characterized by MDMSC at WR-ALC are shown in FY 88 workload Table 10.5-1.

10.5.1 Quick Fix Opportunity to Develop a Mechanic's "Handbook" for Each Repaired Assembly

This quick fix recommendation affects not only MANPSB, but its sister sheet metal repair RCCs, MANPSA, MANPSC, and MANPSD. This opportunity, Develop a Mechanic's Handbook, is already presented in detail under the Quick Fix Opportunity section for MANPSA, paragraph 10.4.1.

10.5.2 Quick Fix Opportunity to Implement Mechanic "Buy-Maintain" Tool-Set Program

This quick fix recommendation affects not only MANPSB, but its sister sheet metal repair RCCs, MANPSA, MANPSC and MANPSD. This opportunity, Implement Mechanic Buy-Maintain Tool-Set Program, is already presented in detail under the Quick Fix Opportunity section for MANPSA, paragraph 10.4.2.

10.5.3 Quick Fix Opportunity To Provide Pictorial - Drawings With the Existing "Workbooks" (WCDs) (MANPSB)

This quick fix recommendation affects not only MANPSB, but its sister sheet metal repair RCCs, MANPSA, MANPSC and MANPSD. This opportunity, Provide Pictorial Drawings With Existing Workbooks (WCDs) is already presented in detail under the Quick Fix Opportunity section for MANPSA, paragraph 10.4.9.

MANPSB MFG. SHEET METAL SHOP FY 88 WORKLOAD
TABLE 10.5-1

PART CONTROL NUMBER (PCN)	FY 88 INDUCTIONS				TOTALS
	1ST QTR	2ND QTR	3RD QTR	4TH QTR	
M0218K	100	110	110	100	420
M0219K	100	110	110	100	420
M0220K	100	110	110	100	420
M0221K	100	110	110	100	420
M0229K	100	110	110	100	420
M1495K	65	65	63	63	256
M1864K	700	780	726	736	2942
M1866K	700	780	726	736	2942
M3651K	200	300	291	290	1081
M3685K	200	300	291	290	1081
M4764K	15	15	14	14	58
M5243K	200	300	303	268	1071
M5351K	200	300	291	290	1081
M5743K	200	300	303	268	1071
M9929K	200	300	303	268	1071

LSC-20330A

10.5.4 Quick Fix Opportunity to Make Available Cobalt-Tipped Drill Bits, or Equivalent, for Mechanic's Use for Drilling Out Fasteners

This quick fix recommendation affects not only MANPSB, but its sister sheet metal repair RCCs, MANPSA, MANPSC and MANPSD. This opportunity, Make Available Cobalt-Tipped Drill Bits, is already presented in detail under the Quick Fix Opportunity section for MANPSA, paragraph 10.4.10.

10.6 MANPSC QUICK FIX OPPORTUNITIES

During the characterization of the MANPSC RCC, MDMSC noted several potential opportunities to improve the performance of the MANPSC repair operation.

This section develops and presents four quick fix opportunities to assist MANPSC in meeting its objectives.

The MANPSC FY 88 inductions per quarter for the five PCNs which were characterized by MDMSC at WR-ALC are shown in FY 88 workload Table 10.6-1.

MANPSC SHEET METAL SHOP FY 88 WORKLOAD
TABLE 10.6-1

PART CONTROL NUMBER (PCN)	FY 88 INDUCTIONS				TOTALS
	1ST QTR	2ND QTR	3RD QTR	4TH QTR	
06692A	55	27	49	49	180
50164A	4	14	12	12	42
50266A	0	0	3	1	4
50454A	1	3	3	5	12
51402A	5	3	2	5	15

LSC-20331A

10.6.1 Quick Fix Opportunity to Develop a Mechanic's "Handbook" for Each Repaired Assembly

This quick fix recommendation affects not only MANPSC, but its sister sheet metal repair RCCs, MANPSA, MANPSB and MANPSD. This opportunity, Develop a Mechanic's Handbook, is already presented in detail under the Quick Fix Opportunity section for MANPSA, paragraph 10.4.1.

10.6.2 Quick Fix Opportunity to Implement Mechanic "Buy-Maintain" Tool-Set Program

This quick fix recommendation affects not only MANPSC, but its sister sheet metal repair RCCs, MANPSA, MANPSB and MANPSD. This opportunity, Implement Mechanic Buy-Maintain Tool-Set Program, is already presented in detail under the Quick Fix Opportunity section for MANPSA, paragraph 10.4.2.

10.6.3 Quick Fix Opportunity To Provide Pictorial - Drawings With the Existing "Workbooks" (WCDs)

This quick fix recommendation affects not only MANPSC, but its sister sheet metal repair RCCs, MANPSA, MANPSB and MANPSD. This opportunity, Provide Pictorial-Drawings With Existing Workbooks (WCDs), is already presented in detail under the Quick Fix Opportunity section for MANPSA, paragraph 10.4.9.

10.6.4 Quick Fix Opportunity to Make Available Cobalt-Tipped Drill Bits, or Equivalent, for Mechanic's Use for Drilling Out Fasteners (MANPSC)

This quick fix recommendation affects not only MANPSC, but its sister sheet metal repair RCCs, MANPSA, MANPSB and MANPSD. This opportunity, Make Available Cobalt-Tipped Drill Bits, is already presented in detail under the Quick Fix Opportunity section for MANPSA, paragraph 10.4.10.

10.7 MANPSD QUICK FIX OPPORTUNITIES

During the characterization of the MANPSD RCC, MDMSC noted several potential opportunities to improve the performance of the MANPSD repair operation.

This section develops and presents six quick fix opportunities to assist MANPSD in meeting its objectives.

The MANPSD FY 88 inductions per quarter for the seven PCNs which were characterized by MDMSC at WR-ALC are shown in FY 88 workload Table 10.7-1.

MANPSD PLASTIC/SHEET METAL SHOP FY 88 WORKLOAD
TABLE 10.7-1

PART CONTROL NUMBER (PCN)	FY 88 INDUCTIONS				TOTALS
	1ST QTR	2ND QTR	3RD QTR	4TH QTR	
03172A	21	39	31	13	104
03427A	6	2	0	2	10
09193A	16	27	29	21	93
40208A	8	15	7	11	41
41059A	13	14	24	36	87
51344A	16	18	14	10	58
51420A	2	0	2	8	12

LSC-20332A

10.7.1 Quick Fix Opportunity to Provide Holding/Support Fixtures For All Radomes (MANPSD)

10.7.1.1 Description of Current Operations

The primary method of support for the radome repair in Building 670 is to place them directly on the floor. Some are elevated off the floor by the mechanics with 2x4s or other makeshift timbers.

Holding stands were made sometime back but are not being used, and their current locations are now unknown.

10.7.1.2 Description of Current Process Problems

Some workers have expressed a desire to have the radomes elevated for better access and comfort.

10.7.1.3 Description of New Process

Holding stands/fixtures should be made to hold the radome on its side and to allow the radome to be rotated. This method would be similar to the holding fixture currently being used with the C-141 nozzle repair effort.

10.7.1.4 Rationale Leading to Change

Repair personnel were observed in Building 670 performing radome repair work on the C-130 and the F-15 radomes with makeshift provisions to aid them in their effort. Some mechanics were sitting on low stools or other boxes in order to get into a more comfortable position to do their work.

Several workers were interviewed and it was revealed that holding fixtures had at one time been provided but they did not provide the correct attitude and positioning to do the work; consequently, they were discarded. Comments were made by some of the workers concerning the desire to be able to rotate the radomes similar to the C-141 nozzle repair effort. Others pointed out that resin flow had to be considered and a repair on the side could not be made without the resin flowing down to the low side.

10.7.1.5 Estimated Cost Savings

An increase of work efficiency from 5% to 10% is predicted (which should increase throughput by a like amount) for all radomes being worked in Building 670. An efficiency increase of 5% would result in a cost savings of: .05 x 1,744 hrs/yr x 90 mechanics x $31.61/hour = $248,075/year.

10.7.1.6 Implementation Cost/Schedule

Based on the cost of the C-141 nozzle repair stands, an engineering ROM estimate of $40,000 should provide adequate fixtures within four to six months.

10.7.2 Quick Fix Opportunity to Provide Capability to Brush Alodine for Building 603 (MANPSD)

10.7.2.1 Description of Current Operations

Parts requiring alodine treatment have to be taken to Building 180, which is about two miles from 603.

No on-site alodine treatment is currently available because of the lack of waste treatment/disposal at Building 603.

10.7.2.3 Description of New Process

Either one of the following would suffice but MDMSC considers (1) and (2) as temporary solutions only.

(1) Step up the existing "Fast-Flow" pick-up and delivery system for the parts.

(2) Temporarily, provide a collection drum with adequate exhaust/vent system at Building 603 and transfer the toxic waste to the industrial wastewater treatment plant or off-site for disposal. A drum for contaminated solid waste must also be provided.

(3) Tie in to an existing waste disposal line at Building 645. (This item was rejected by WR-ALC sometime in 1987. Kevin Warnock 926-4446 has information on the 1987 proposal.)

10.7.2.4 Rationale Leading to Change

During the characterization of the MANPSD RCCs associated with Buildings 603 and 670 at WR-ALC, workers were observed hand carrying parts to Building 180, approximately 1/2 mile away to be alodine treated. Investigation revealed that a study was conducted in 1987 to tie into the waste disposal line at Building 645 but was rejected as not being cost effective. This was discussed with Kevin Warnock at the time.

10.7.2.5 Estimated Cost Savings

The estimated cost would be contingent on the decision as to the selection of (1), (2), or (3) as described above in paragraph 10.7.2.3. Number (1) is estimated to be the least expensive and (3) the most expensive with (2) somewhere in between, but only as a temporary measure because of adverse environmental conditions.

Number (3) would be the ideal method to provide treatment and is recommended by MDMSC.

10.7.2.6 Implementation Cost/Schedule

Implementation cost of process number (3) with the 1987 cost and schedule is contingent on the process selected. MDMSC recommends the cost implementation scaled up to the 1990 cost values and schedule.

- (1) Shortest time to implement
- (2) Somewhere in between (1) and (3)
- (3) Longest time

10.7.3 Quick Fix Opportunity to Develop a Mechanic's "Handbook" for Each Repaired Assembly

This quick fix recommendation affects not only MANPSD, but its sister sheet metal repair RCCs, MANPSA, MANPSB and MANPSC. This opportunity, Develop a Mechanic's Handbook, is already presented in detail under the Quick Fix Opportunity section for MANPSA, paragraph 10.4.1.

10.7.4 Quick Fix Opportunity to Implement Mechanic "Buy-Maintain" Tool-Set Program

This quick fix recommendation affects not only MANPSD, but its sister sheet metal repair RCCs, MANPSA, MANPSB and MANPSC. This opportunity, Implement Mechanic "Buy-Maintain" Tool-Set, is already presented in detail under the Quick Fix Opportunity section for MANPSA, paragraph 10.4.2.

10.7.5 Quick Fix Opportunity To Provide Pictorial - Drawings With the Existing "Workbooks" (WCDs)

This quick fix recommendation affects not only MANPSD, but its sister sheet metal repair RCCs, MANPSA, MANPSB and MANPSC. This opportunity, Provide Pictorial-Drawings With the Existing Workbooks, is already presented in detail under the Quick Fix Opportunity section for MANPSA, paragraph 10.4.9.

10.7.6 Quick Fix Opportunity to Make Available Cobalt-Tipped Drill Bits, or Equivalent, for Mechanic's Use for Drilling Out Fasteners

This quick fix recommendation affects not only MANPSD, but its sister sheet metal repair RCCs, MANPSA, MANPSB and MANPSC. This opportunity, Make Available Cobalt-Tipped Drill Parts, is already presented in detail under the Quick Fix Opportunity section for MANPSA, paragraph 10.4.10.